

DOT/FAA/CT-83/21
(NRL Report 8738)

AD A137589

A New Data Base of Supercooled Cloud Variables for Altitudes up to 10,000 Feet AGL and the Implications for Low Altitude Aircraft Icing

Richard K. Jeck

Atmospheric Physics Branch
Environmental Sciences Division
Naval Research Laboratory
Washington, D. C. 20375



August 1983

Final Report

This document is available to the U.S. public
through the National Technical Information
Service, Springfield, Virginia 22161.

APPROVED FOR PUBLIC RELEASE
DISTRIBUTION UNLIMITED



US Department of Transportation
Federal Aviation Administration
Technical Center
Atlantic City Airport, N.J. 08405

DTIC
ELECTE
FEB 08 1984
S E D

DTIC FILE COPY

84 02 07 121

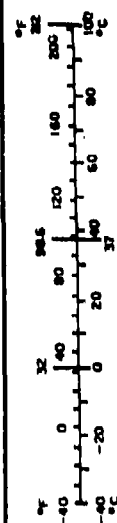
NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

| | | | | | |
|--|--|--|--|---|--|
| 1. Report No. DOT/FAA/CT-83/21 (NRL Report 8738) | | 2. Government Accession No. <i>AD-A137589</i> | | 3. Recipient's Catalog No. | |
| 4. Title and Subtitle A NEW DATA BASE OF SUPERCOOLED CLOUD VARIABLES FOR ALTITUDES UP TO 10,000 FT AGL AND THE IMPLICATIONS FOR LOW ALTITUDE AIRCRAFT ICING | | | | 5. Report Date August 1983 | |
| | | | | 6. Performing Organization Code | |
| | | | | 8. Performing Organization Report No. | |
| 7. Author(s) Richard K. Jeck | | | | 10. Work Unit No. (TRIS) | |
| 9. Performing Organization Name and Address Naval Research Laboratory 4555 Overlook Avenue, SW Washington, DC 20375 | | | | 11. Contract or Grant No. 182-340-200 | |
| | | | | 13. Type of Report and Period Covered Final Report January 1979 to June 1982 | |
| 12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Technical Atlantic City Airport, NJ 08405 | | | | 14. Sponsoring Agency Code FAA/ACT-340 | |
| 15. Supplementary Notes FAA Contract FA79WAI-020 | | | | | |
| 16. Abstract <p>About 7000 nautical miles (nmi) of airborne measurements in a variety of supercooled cloud types and weather conditions up to 10,000 feet (3 kilometers) above ground level (AGL) have been computerized to form a new Data Base of cloud variables applicable to low altitude aircraft icing studies. Half of the data is from the aircraft icing research flights conducted by the National Advisory Committee for Aeronautics (NACA) in 1946-50. The other half is from recent wintertime research flights by the Naval Research Laboratory and other organizations, mostly over the conterminous United States (CONUS) and nearby offshore areas. The Data Base includes liquid water content (LWC), cloud droplet median volume diameter (MVD), true outside air temperature (OAT), horizontal extent and altitude of uniform cloud intervals as well as information on cloud type, weather conditions, date and geographic location, and other data.</p> <p>A variety of analyses are illustrated which yield these principal conclusions: The NACA and modern CONUS measurements generally agree in most aspects for similar amounts of data in similar cloud and weather conditions. The Intermittent Maximum and Continuous Maximum "envelopes" in the Federal Aviation Regulations, Part 25 (FAR-25), Appendix C, do not correctly describe the icing environment for altitudes up to 10,000 feet AGL. The average ice accretion rate appears to be independent of altitude between 2000 and 10,000 feet AGL.</p> | | | | | |
| 17. Key Words Aircraft Icing Helicopter Icing Aircraft Certification Icing Envelopes Supercooled Clouds | | Liquid Water Content Icing Condi- tions | | 18. Distribution Statement Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22151 | |
| 19. Security Classif. (of this report) Unclassified | | 20. Security Classif. (of this page) Unclassified | | 21. No. of Pages 22. Price | |

METRIC CONVERSION FACTORS

| Approximate Conversions from Metric Measures | | | |
|--|-------------|---------------------------|-----------------|
| When You Know | Multiply by | To Find | Symbol |
| LENGTH | | | |
| meters | 0.09 | inches | m |
| centimeters | 0.4 | inches | cm |
| millimeters | 3.3 | inches | mm |
| centimeters | 1.1 | inches | cm |
| millimeters | 0.5 | inches | mm |
| AREA | | | |
| square centimeters | 0.16 | square inches | cm ² |
| square meters | 1.2 | square yards | m ² |
| square kilometers | 0.4 | square miles | km ² |
| hectares (10,000 m ²) | 2.5 | acres | ha |
| MASS (weight) | | | |
| grams | 0.005 | ounces | g |
| kilograms | 2.2 | pounds | kg |
| tonnes (1000 kg) | 1.1 | short tons | t |
| VOLUME | | | |
| milliliters | 0.03 | fluid ounces | ml |
| liters | 2.1 | pints | l |
| hectoliters | 1.4 | gallons | hl |
| cubic meters | 0.28 | cubic feet | m ³ |
| cubic centimeters | 36 | cubic inches | cc |
| cubic meters | 1.3 | cubic yards | m ³ |
| TEMPERATURE (exact) | | | |
| °C | | °F (other subtracting 32) | °C |
| | | Fahrenheit temperature | |



*1 in = 2.54 cm exactly. For other exact conversions and more detailed tables, see NBS Mon., Pub. 75-6, Units of Length and Mass, N-Gr 12.25, 50 Catalog No. C11.17-25.

PREFACE

This research project has benefitted from the assistance and experience of a number of people.

Ronald C. Beattie and Ben J. Julian of NRL provided invaluable technical assistance in the installation, maintenance, and improvement of NRL's airborne cloud physics instrumentation.

Appreciation is given to the following persons for their help and cooperation in providing quality processed data for inclusion in the new Data Base:

Wayne Sand, Marcia Politovich, and Todd Sherman of the University of Wyoming; Larry Jahnsen, Mark Humbert, Robert Anderson, and Don Takeuchi of Meteorology Research, Inc.; Jean-Francois Gayet of the Laboratoire Associe de Meteorologie Physique of the University of Clermont II in France; Lawrence Radke, Peter Hobbs, Art Rangno, and Douglas Bell of the University of Washington; Morton Glass of the Air Force Geophysical Laboratories (USAF/AFGL); and Porter Perkins of the NASA/Lewis Research Center.

Helpful discussion and commentary were provided by Art Hilsenrod, Richard Adams, Charles Masters, and Ernest Schlatter of the FAA and by John Reinmann, William Olsen, and Porter Perkins of the NASA/Lewis Research Center.

Credit is due to the following naval officers who were students in a meteorology course taught by the author during one year spent as the NAVAIR Research Associate Professor in Meteorology at the U.S. Naval Academy while this research project was under way. These officers, then midshipmen 1/c, participated in some of the NRL research flights and worked up segments of the data. They are: John Bitman, Vincent Calvente, Margaret DeLuca, T.B. Fleischer, Steve Fortunato, Victor McCree, William P. Morgan, David Mutzabaugh, Fred E. Smith, Louis S. Steckler, Milton Stretton, Edmund L. Turner, James T. Vazquez, and Mark Washington.

In addition, Ensigns Mary B. Clifford and Richard Cianflone helped substantially in preparing the NACA data for inclusion into the computerized Icing Data Base.

Bernie Ulfers at NRL gave valuable assistance in development of the computer codes for the computer graphics used in this report.



| | |
|--------------------|--|
| Accession For | |
| NTIS GRA&I | <input checked="checked" type="checkbox"/> |
| DTIC TAB | <input type="checkbox"/> |
| Unannounced | <input type="checkbox"/> |
| Justification | |
| By _____ | |
| Distribution/ | |
| Availability Codes | |
| Dist | Avail and/or Special |
| A-1 | |

TABLE OF CONTENTS

| | Page |
|--|------|
| EXECUTIVE SUMMARY | xi |
| INTRODUCTION | 1 |
| Motivation for the Research | 1 |
| Scope of the Research Project | 2 |
| Other Background Information | 2 |
| RESULTS | 7 |
| The New Icing Data Base | 7 |
| 'Data Miles' As a Measure of Frequency of Occurrence | 10 |
| Review of the NACA Data | 10 |
| Analyses and Comparison of the NACA and Modern Data | 11 |
| Horizontal Extent | 19 |
| CONCLUSIONS | 23 |
| REFERENCES | 27 |
| APPENDIX A - The New Data Base for Supercooled Clouds Below 10,000 ft AGL | |
| APPENDIX B - How Much Data is Enough? Coverage of Cloud Types, Weather Categories, and Geographic Regions | |
| APPENDIX C - Application of the New Data Base to the Army Icing Test Matrix | |
| APPENDIX D - Application of the New Data Base to the USAF/ETAC Cloud Liquid Water Model (3D-NEPH and the Smith-Feddes LWC Model) | |

LIST OF ILLUSTRATIONS

| <u>Figure</u> | | <u>Page</u> |
|---------------|---|-------------|
| 1 | Continuous Maximum Icing Envelope | 29 |
| 2 | Continuous Maximum Envelope of Temperature vs. Altitude | 29 |
| 3 | Adjustment Factor for LWC vs. Cloud Horizontal Extent for Continuous Maximum Icing Conditions | 30 |
| 4 | Intermittent Maximum Icing Envelope | 30 |
| 5 | Intermittent Maximum Envelope of Temperatures vs. Altitude | 31 |
| 6 | Adjustment Factor for LWC vs. Cloud Horizontal Extent for Intermittent Icing Conditions | 31 |
| 7 | Altitude Variation of Supercooled LWC for All Cloud Types as Observed in the NACA Data (1946-1950) | 32 |
| 8 | Altitude Variation of Supercooled LWC for All Cloud Types as Observed in the Modern Data | 32 |
| 9 | Cumulative Variation With Altitude for Supercooled LWC from All Cloud Types in the Entire CONUS Data Base | 33 |
| 10 | Altitude Variation of Horizontal Extents of Extended Icing Encounters in Layer Clouds (St, Sc, Ns, As, Ac) as Observed in the NACA Data (1946-1950) | 33 |
| 11 | Altitude Variation of Horizontal Extents of Extended Icing Encounters in Layer Clouds (St, Sc, Ns, As, Ac) as Observed in the Modern Data | 34 |
| 12 | Altitude Variation of Horizontal Extents of Extended Icing Encounters in Convective Clouds (Cu, Cb) as Observed in the NACA Data (1946-1950) | 34 |
| 13 | Altitude Variation of Horizontal Extents of Extended Icing Encounters in Convective Clouds (Cu, Cb) as Observed in the Modern Data | 35 |
| 14 | Altitude Variation of Average Ice Accretion per Extended Icing Encounter as Determined from the NACA Data (1946-1950) | 36 |

LIST OF ILLUSTRATIONS (CONT'D)

| <u>Figure</u> | | <u>Page</u> |
|---------------|---|-------------|
| 15 | Altitude Variation of Average Ice Accretion per Extended Icing Encounter as Determined from the Modern Data | 36 |
| 16 | Altitude Variation of Average Ice Accretion per Extended Icing Encounter as Determined from the Combined NACA and Modern Data | 37 |
| 17 | Frequency Distribution of LWC in All Supercooled Cloud Types up to 10,000 ft AGL as Observed in the NACA Data (1946-1950) | 37 |
| 18 | Frequency Distribution of LWC in All Supercooled Cloud Types up to 10,000 ft AGL as Observed in the Modern Data | 38 |
| 19 | Frequency Distribution of LWC in All Supercooled Cloud Types up to 10,000 ft AGL as Observed in the Combined NACA and Modern Data | 38 |
| 20 | Scatterplot of Observed LWC, MVD Combinations in the NACA Data for Layer Clouds up to 10,000 ft AGL and for Cloud Temperatures from -10°C to 0°C | 39 |
| 21 | Scatterplot of Observed LWC, MVD Combinations in the NACA Data for Layer Clouds up to 10,000 ft AGL and for Cloud Temperatures from -20°C to -10°C | 40 |
| 22 | Scatterplot of Observed LWC, MVD Combinations in the NACA Data for Convective Clouds up to 10,000 ft AGL and for Cloud Temperatures from -10°C to 0°C | 41 |
| 23 | Scatterplot of Observed LWC, MVD Combinations in the NACA Data for Convective Clouds up to 10,000 ft AGL and for Cloud Temperatures from -20°C to -10°C | 42 |
| 24 | Scatterplot of Observed LWC, MVD Combinations in the Modern Data for Layer Clouds up to 10,000 ft AGL and for Cloud Temperatures from -10°C to 0°C | 43 |
| 25 | Scatterplot of Observed LWC, MVD Combinations in the Modern Data for Layer Clouds up to 10,000 ft AGL and for Cloud Temperatures from -20°C to -10°C | 44 |

LIST OF ILLUSTRATIONS (CONT'D)

| <u>Figure</u> | | <u>Page</u> |
|---------------|---|-------------|
| 26 | Scatterplot of Observed LWC, MVD Combinations in the Modern Data for Layer Clouds up to 10,000 ft AGL and for Cloud Temperatures from -30°C to -20°C | 45 |
| 27 | Scatterplot of Observed LWC, MVD Combinations in the Modern Data for Convective Clouds up to 10,000 ft AGL and for Cloud Temperatures from -10°C to 0°C | 46 |
| 28 | Scatterplot of Observed LWC, MVD Combinations in the Modern Data for Convective Clouds up to 10,000 ft AGL and for Cloud Temperatures from -20°C to -10°C | 47 |
| 29 | Scatterplot of Icing Event Temperatures vs. Altitude for Modern Data from Supercooled Layer Clouds (St, Sc, Ns, As, Ac) up to 10,000 ft AGL | 48 |
| 30 | Scatterplot of Icing Event Temperatures vs. Altitude for NACA Data from Supercooled Layer Clouds (St, Sc, Ns, As, Ac) up to 10,000 ft AGL | 49 |
| 31 | Scatterplot of Icing Event Temperatures vs. Altitude for Modern Data from Supercooled Convective Clouds (Cu, Cb) up to 10,000 ft AGL | 50 |
| 32 | Scatterplot of Icing Event Temperatures vs. Altitude for NACA Data from Supercooled Convective Clouds (Cu, Cb) up to 10,000 ft AGL | 51 |
| 33 | Scatterplot of LWC vs. OAT for Modern Data from Supercooled Layer Clouds (St, Sc, Ns, As, Ac) up to 10,000 ft AGL | 52 |
| 34 | Scatterplot of LWC vs. OAT for NACA Data from Supercooled Layer Clouds (St, Sc, Ns, As, Ac) up to 10,000 ft AGL | 53 |
| 35 | Scatterplot of LWC vs. OAT for Modern Data from Supercooled Convective Clouds (Cu, Cb) up to 10,000 ft AGL | 54 |
| 36 | Scatterplot of LWC vs. OAT for NACA Data from Supercooled Convective Clouds (Cu, Cb) up to 10,000 ft AGL | 55 |

LIST OF ILLUSTRATIONS (CONT'D)

| <u>Figure</u> | | <u>Page</u> |
|---------------|--|-------------|
| 37 | Selected, Cumulative Frequencies of Occurrence of LWC vs. Temperature for the Entire CONUS Data Base | 56 |
| 38 | Scatterplot of MVD vs. OAT for Modern Data from Supercooled Layer Clouds (St, Sc, Ns, As, Ac) up to 10,000 ft AGL | 57 |
| 39 | Scatterplot of MVD vs. OAT for NACA Data from Supercooled Layer Clouds (St, Sc, Ns, As, Ac) up to 10,000 ft AGL | 58 |
| 40 | Scatterplot of MVD vs. OAT for Modern Data from Supercooled Convective Clouds (Cu, Cb) up to 10,000 ft AGL | 59 |
| 41 | Scatterplot of MVD vs. OAT for NACA Data from Supercooled Convective Clouds (Cu, Cb) up to 10,000 ft AGL | 60 |
| 42 | Scatterplot of NACA Observed Horizontal Extents of Individual Icing Events vs. Average LWC Over the Event | 61 |
| 43 | Scatterplot of Modern Observed Horizontal Extents of Individual Icing Events vs. Average LWC Over the Event | 62 |
| 44 | Scatterplot of Modern Observed Horizontal Extents of Entire Icing Encounters vs. Average LWC Over the Encounter | 63 |
| 45 | Scatterplot of Modern Observed Horizontal Extents of Entire Icing Encounters vs. Average LWC Over the Encounter | 64 |
| 46 | Scatterplot of Modern Observed Horizontal Extents of Entire Icing Encounters vs. Average LWC Over the Encounter | 65 |
| 47 | Approximate Extreme Values of LWC and MVD Combinations Observed in Supercooled Clouds at Altitudes up to 10,000 ft AGL | 66 |

LIST OF ABBREVIATIONS

| | | |
|---------------|---|--|
| AGL | - | above ground level |
| CONUS | - | Conterminous United States |
| FAA | - | Federal Aviation Administration |
| FAR-25 | - | Federal Aviation Regulations, Part 25 |
| IFR | - | Instrument Flight Rules |
| IMC | - | Instrument Meteorological Conditions |
| kt | - | knot(s) |
| L.A.M.P. | - | Laboratoire Associe de Meteorologie Physique (Univ. Clermont II, France) |
| LWC | - | Liquid water content |
| MRI | - | Meteorology Research, Inc. |
| NACA | - | National Advisory Committee for Aeronautics |
| nmi | - | nautical mile |
| NRL | - | Naval Research Laboratory |
| OAT | - | Outside Air Temperature |
| UWSH | - | University of Washington (Seattle) |
| UWY | - | University of Wyoming |
| USAF/AFGL | - | United States Air Force/Air Force Geophysical Laboratories |
| USAF/ETAC | - | United States Air Force/Environmental Technical Applications Center |
| μm | - | micron (10^{-6} meter) |

EXECUTIVE SUMMARY

This report is in response to a growing requirement over the last decade for a new assessment of aircraft icing conditions in wintertime clouds at altitudes up to about 10,000 ft. Currently, no helicopters and few general aviation aircraft are certified for flight in known icing conditions. This is because the current FAA criteria for design and certification of ice protection equipment results in relatively high power and payload penalties for smaller aircraft. The FAA criteria (promulgated in the Federal Aviation Regulations, Part 25 (FAR-25), Appendix C; also shown as Figures 1 to 6 of this report) were actually designed for large, transport-category aircraft capable of flying to 20,000 ft or more. For this reason, there have been concerns that the current criteria may be too severe for smaller aircraft which generally operate at altitudes below 10,000 ft.

The aircraft icing hazard comes from the fact that undisturbed cloud droplets generally remain liquid even at temperatures several tens of degrees below freezing-- a condition called supercooling. When they collide with a passing aircraft, the droplets freeze nearly instantaneously to form ice on exposed aircraft surfaces. The amount of ice depends primarily on the liquid water content (LWC) of the cloud, the size of the droplets, the temperature of the aircraft surfaces and, of course, on the horizontal extent of the supercooled clouds along the flight path. Information on the natural occurrence of these variables is obtained from research flights through subfreezing clouds.

The current FAA characterizations of supercooled clouds in FAR-25 are based on research flights undertaken about 35 years ago. Recent advances in cloud physics instrumentation have therefore prompted calls for new measurements and for a re-evaluation of the old data for accuracy and reliability. The net requirement is for a reliable, quantitative description of supercooled cloud characteristics over the altitude range from ground level to 10,000 ft.

In response to this requirement, the Naval Research Laboratory (NRL) has computerized about 7000 nautical miles (nmi) of airborne measurements in supercooled clouds at altitudes up to 10,000 ft (3 km) to form a new data base for low altitude, aircraft icing applications. Half of the data is from the National Advisory Committee for Aeronautics (NACA) aircraft icing studies of 1946-50 where ice accretion on rotating multicylinders was the primary measurement technique for LWC and droplet size. The other half is from recent research flights by NRL and other organizations using optical, cloud droplet size spectrometers manufactured by Particle Measuring Systems. These measure droplet sizes, with LWC being measured by electronic hot-wire devices as well as being computed from the recorded droplet size distribution.

The principal conclusions relevant to aircraft ice protection for altitudes up to 10,000 ft above ground level (AGL) are:

1. The NACA and modern data generally agree in most aspects, indicating that the NACA data are accurate and reliable except possibly for droplet diameters larger than 35 μm .

2. The "Intermittent Maximum" (convective cloud) and "Continuous Maximum" (layer cloud) ranges of cloud variables in FAR-25, App. C do not correctly describe the icing environment in the altitude interval from 0 to 10,000 ft AGL. The differences are in the following items:

a) The maximum observed LWC for convective clouds below 10,000 ft AGL is about half the "Intermittent Maximum" value. The maximum observed LWC for layer clouds below 10,000 ft AGL is about 50% larger than the "Continuous Maximum" value.

b) The new analyses reveal temperature dependences of droplet median volume diameter (MVD) that are not conveyed in the FAR-25 envelopes. The Continuous Maximum and Intermittent Maximum envelopes extend to fixed, maximum MVDs of 40 and 50 μm , respectively. The modern data demonstrate that the maximum MVD in layer clouds decreases with decreasing temperature. Both the NACA and modern CONUS data show that for convective clouds the average MVD exhibits the opposite behavior and increases with decreasing temperature.

c) The modern data show no credible MVDs larger than about 35 μm for droplets in supercooled clouds below 10,000 ft AGL. The few MVDs that are reported to be larger than 35 μm in the NACA data are questionable in view of the assessment by the NACA researchers themselves that these large MVDs are likely to contain large positive errors due to the limitations of the multicylinder technique.

3. The FAR-25 envelopes extend to at least -30°C but minimum temperatures observed in both the NACA and modern data below 10,000 ft AGL are -17°C for convective clouds and about -25°C for layer clouds. That is, convective clouds appear to be completely absent at temperatures less than about -17°C at altitudes below 10,000 ft AGL.

4. A review of the literature reveals no standard definition of horizontal extent nor do the FAR-25 regulations specify how horizontal extent is to be determined when cloud gaps are present. As a result, confusing and inconsistent interpretations occur in practice. It is suggested here that horizontal extent be defined as the distance traveled in supercooled clouds until the aircraft reaches a cloud gap of some specified minimum duration, such as 1 nmi, for example. With this definition it is found that the maximum, and to a lesser degree the average horizontal extent varies in an inverse manner with the LWC averaged over the clouds comprising the horizontal extent. But short horizontal extents are actually most common regardless of the average LWC value.

5. Finally, a new finding with respect to the altitude dependence of icing conditions is that between 2000 and 10,000 ft AGL, altitude makes practically no difference in the maximum amount of ice accretion to be expected per icing encounter when all supercooled cloud types are considered together.

INTRODUCTION

MOTIVATION FOR THE RESEARCH

This study was undertaken in response to a growing requirement for a reliable, quantitative description of low altitude, wintertime cloud characteristics that are relevant to aircraft icing. The liquid water content (LWC) and size distribution of droplets in supercooled clouds, as well as the cloud temperature and horizontal extent of icing conditions, are generally considered to be the most important environmental factors involved in ice accretion processes. Information on these variables at altitudes below 10,000 ft (3 km) or so is needed by helicopter manufacturers who want to produce rotorcraft capable of flying into known icing conditions. (At the present time, a few military types of helicopters are about the only rotorcraft equipped with ice protection devices.) The Federal Aviation Administration (FAA), as the responsible regulatory agency, needs the same information in order to specify icing environmental criteria for the manufacturers to use in designing ice protection equipment. The FAA and military also use this type of information for specifying the requirements of actual flight certification tests in icing conditions.

At the time this study was begun, the available data on the icing environment over the United States was almost entirely from research performed 30 to 35 years ago for similar reasons by the National Advisory Committee for Aeronautics (NACA). They obtained airborne measurements for use in design and certification of ice protection equipment for the expanding, postwar, commercial airline industry. Those measurements still form the basis of current design and certification criteria for the icing environment as promulgated in Federal Aviation Regulations, Part 25, Appendix C (FAR-25, App. C).

Presently any helicopter which is a candidate for icing certification must meet these same criteria that were developed for larger "transport category" aircraft designed to fly to altitudes of 20,000 ft or more. These criteria contain LWC values that could be prohibitive in terms of the power and payload penalties required to provide compensating ice protection equipment for many helicopters. For this reason there is an interest in finding out whether at altitudes of 10,000 ft or less, the altitude operating range for most helicopters, icing conditions may be significantly less severe than current regulations specify. If so, and if new icing criteria were to be issued that represented the less severe conditions and at the same time limited flight to altitudes below the appropriate level, then other light duty, low-performance aircraft might benefit as well. Questions have also arisen about the effect of snow or other mixed conditions on the rate of ice accretion. Low-altitude icing also implies a need to investigate geographical, topographical, or other mesoscale influences too. For example, LWC values may be enhanced in lake effect clouds, orographically assisted cloud formations, and clouds along cold fronts or in maritime air masses.

In addition to the engineering concerns, there have been calls for improved icing forecasts and for redefining the icing severity classifications in terms of quantitative LWC values instead of the relative and ambiguous terminology, "trace," "light," "moderate," etc. that is now in use.

Recent advances in cloud physics instrumentation have also prompted calls for the review of the 30 to 35 year old NACA data in order to assess their accuracy and reliability. In addition, it is of interest to determine how much of the data actually apply to altitudes below both 10,000 ft and 5000 ft, and how well the data represent the variety of weather and cloud conditions at these altitudes.

Finally, there was an obvious need to obtain new data with modern instrumentation. The results would naturally be compared with the NACA data to look for significant differences which may indicate either errors in one or both sets of data or, as some have suggested, true changes in cloud characteristics brought about by changes in pollution levels over the intervening years. New measurements may also be needed to supplement data from any cloud types, weather situations, or geographic locations inadequately sampled by the NACA researchers.

SCOPE OF THE RESEARCH PROJECT

In order to address these problems the FAA funded the Experimental Cloud Physics Section of the Naval Research Laboratory (NRL), beginning in January 1979, to perform research on these topics. Specifically, the research plan was as follows.

- a) Obtain new measurements of LWC, droplet size spectra, true air temperature and other relevant variables using modern cloud physics instrumentation aboard NRL's research aircraft in subfreezing clouds below 10,000 ft and especially below 5000 ft.
- b) Collect similar modern data that are available from other research groups.
- c) Review the NACA data for accuracy, reliability, and applicability to altitudes below 10,000 ft and below 5000 ft.
- d) Compile all acceptable data into a medium that is compatible with automatic data processing in order to form a new data base for analysis of the low-altitude icing environment.
- e) Perform analyses of the data and, based on an assessment of all data obtained, recommend appropriate changes in the existing environmental icing criteria.

OTHER BACKGROUND INFORMATION

1. FAR-25, Appendix C, Atmospheric Icing Conditions

The primary reference data given in the Federal Aviation Regulations, Part 25, (FAR-25) to describe icing cloud characteristics are the LWC vs. Median Volume Diameter (MVD) relationships in figures 1 and 4 of Appendix C in that document. Those figures are reproduced here also as figures 1 and 4 of this report. Combinations of LWC and MVD that fall within the boundaries of these "envelopes" were reported to have sufficient probability of occurring

simultaneously, that they were to be regarded as significant for ice protection considerations (Jones and Lewis, 1949, p. 2). NACA researchers also noted that the maximum observed LWCs were limited by the air temperature at cloud level. This temperature dependence has been worked into the icing "envelopes" by specifying the probable maximum values of LWC as a function of MVD and temperature. "Probable maximum" is the terminology used in NACA TN-1855 (Jones and Lewis, 1949), the source document for FAR-25, Appendix C. "Probable maximum" was defined as the maximum that would probably be encountered in all weather aircraft operations but does not represent the maximum that nature could produce (ibid., p. 5). No numerical probability was associated with the term "probable maximum" until a later statistical study (Lewis and Bergrun, 1952, pp. 19-20) concluded that the probable maximum LWCs [of FAR-25, App. C] correspond to an exceedance probability of about 0.1%. The "isotherms" drawn in 10°C increments from 32°F (0°C) to -22°F (-30°C) in figures 1 and 4 delimit the probable maximum values of LWC at each of these temperatures.

The NACA criteria originally specified in TN-1855 actually contained seven different types of icing conditions, each with a time or distance extent that varied with the corresponding type of cloud and LWC range. In practice, only two of these conditions, the "intermittent maximum" and the "continuous maximum," were promulgated in FAR-25. The philosophy behind the two-condition approach is presumably to ensure that aircraft de-icing equipment can handle relatively small LWCs for long periods of time, and relatively large LWCs for a short time in the most commonly experienced icing situations.

The explanatory text accompanying the figures in Appendix C of FAR-25 is quoted as follows for continuous maximum icing: "The maximum continuous intensity of atmospheric icing conditions (continuous maximum icing) is defined by the variables of the cloud liquid water content, the mean effective diameter of the cloud droplets, the ambient air temperature, and the interrelationship of these three variables as shown in figure 1 of [FAR-25, App. C]. The limiting icing envelope in terms of altitude and temperature is given in figure 2 of [FAR-25, App. C]. The interrelationship of cloud liquid water content with drop diameter and altitude is determined from figures 1 and 2. The cloud liquid water content for continuous maximum icing conditions of a horizontal extent other than 17.4 nautical miles (nmi) is determined by the value of liquid water content of figure 1, multiplied by the appropriate factor from figure 3." A similar explanatory text applies to the intermittent maximum conditions covered in figures 4, 5, and 6, and specifies a standard horizontal extent of 2.6 nmi.

No other rules or guidance for using these envelopes in design computations or in certification flight tests are given in FAR-25.

2. Cloud Liquid Water Content (LWC)

a. Engineering Significance

Nearly all ice that forms in flight on aircraft surfaces is due to the impaction and freezing of supercooled cloud droplets. Supercooled droplets are those which remain liquid even though the ambient cloud temperature is less than 0°C. This supercooled state is a metastable one, meaning that the droplets can remain liquid indefinitely unless the temperature becomes too low

or the droplets are mechanically disturbed. Once disturbed, such as upon collision with an aircraft component, the droplets freeze rapidly depending on their size and on the temperature of the air and of the aircraft surfaces. Small droplets freeze instantaneously and form rime ice on aircraft surfaces. Large droplets tend to run back somewhat before freezing.

Despite the metastable state, supercooled clouds are the rule rather than the exception for ambient temperatures down to at least -10°C . Thus the rate of ice accretion on aircraft components is directly proportional to the liquid water content of the supercooled cloud in which the flight takes place.

b. Meteorological Considerations

The principal factors conducive to large values of LWC in clouds are warm, moist air masses and strong convection or forced updrafts within the cloud. Fortunately, for the aircraft icing problem, both of these factors are minimized in wintertime climates.

Higher temperatures permit the air masses to carry greater amounts of water vapor from which clouds must form. The greater the water vapor load in the subcloud air, the greater the possible LWC in the clouds formed from it.

The maximum LWC in a cloud also depends on the strength of the convection or the rate of updraft in the cloud. The higher surface temperatures that can induce strong convection are of course lacking in wintertime climates. There are exceptions, however, which are important in the altitude regime below 10,000 ft. One of these exceptions is the "lake effect" situation where relatively warm lake or ocean waters provide additional moisture and induce convection in colder air masses advecting across them. Notable occurrences of this phenomenon in North America are over the Great Lakes and over the ocean waters along the mid-Atlantic seaboard states, especially in the vicinity of the Gulf Stream. Another possible exception is the case of a strong cold front pushing into a warm, moist air mass. In this case again, both the greater water vapor content of the warm air and the forced lifting of this air over the cold frontal surface are conducive to greater than usual LWCs. A third exception is where forced lifting occurs on the windward side of mountain ranges. These orographic effects are known to be significant along the Appalachian range. They would be expected to have an even greater effect on LWC along the Pacific coast ranges where the maritime air masses are moist and the mountains are higher.

The greatest icing hazards occur in warm weather cumulonimbus (Cb) clouds, or developing thunderstorms, where LWCs up to 5 g/m^3 have been reported. However, the freezing level in these clouds is usually above 10,000 ft AGL, and icing hazards are therefore of little concern to aircraft at lower flight levels. Indeed the other hazards present in these clouds or storms will generally be far more worrisome. In any case, these cloud types are relatively easy to identify and are sufficiently localized or transient that they can normally be avoided.

Wintertime stratus not associated with cyclonic centers or with strong frontal systems is expected to be low in LWC both because of the low water vapor content of the surrounding cold air and the lack of significant

convection. Observation also reveals that even in the deep and extensive altostratus and nimbostratus complexes comprising the general snow areas of cyclonic storms, liquid cloud droplets are almost completely absent in the subfreezing portions of the clouds (Lewis, 1969, p. 7), (Kline and Walker, 1951). Finally, during cold air outbreaks from central Canada into the central plains states, the western edge of the cold air mass is sometimes forced westward and upward over the gradually increasing elevation of the terrain. This "upslope flow" usually forces stratus formation but because of the dryness of the cold air mass the LWC is expected to be small in the upslope stratus.

This leaves frontal systems, lake effects and orographic situations as the principal candidates for contributing the most significant LWCs in wintertime cloud systems at altitudes below 10,000 ft AGL.

3. Cloud Droplet Size Distribution

Engineering Significance

The size distribution of cloud droplets and the percentage of liquid water represented by various droplet size intervals is also important. This is because the efficiency with which aircraft components collect droplets from the airstream varies with droplet diameter as well as airspeed and the size and shape of the aircraft component. Smaller droplets are more easily deflected and tend to follow the airstream around an object in their path. The larger the droplet, the greater its inertia and its tendency to slip across streamlines upon approaching an object. Thus, larger droplets will be collected with greater efficiency than smaller droplets. Therefore, whether the majority of the LWC resides in small or large droplets can be an important factor in the design of ice protection equipment.

Qualitatively speaking, blunt objects such as fuselages have relatively low collection efficiencies for all except the largest droplet sizes. This is because blunt objects distort the airstream farther ahead and give the droplets more time and therefore slower curving streamlines to follow to get out of the way. Sharp objects, such as the leading edge of rotor blades, have high collection efficiencies for all droplet sizes, especially along the outer portions of the blade where it is the thinnest. Also, the linear velocity of the blade increases with distance from the hub and adds to the increased efficiency of the outboard sections compared to the thicker, slower moving portions of the blade toward the hub.

For many applications it is often too cumbersome to work with elaborate droplet size distributions. There is a need for a simple, quantitative representation of droplet size distribution which would be meaningful for engineering computations as well as for statistical analyses of icing conditions. For this purpose the median volume diameter (MVD), also known as mass median diameter, is generally chosen. The MVD is useful because it is the droplet size which equally divides the LWC associated with a given droplet size distribution. Half of the LWC is in droplets larger than the MVD and half of the LWC is in droplets smaller than the MVD.

Because of the difficulty in accurately determining the droplet size distribution with the techniques available at the time, the NACA researchers preferred to use the term "mean effective diameter." This is an approximation to the MVD that is based on the apparent size distribution deduced from the relative amounts of ice that built up on the different diameter cylinders used by the NACA researchers to probe the clouds for LWC. The more closely the deduced size distribution matched the true size distribution, the better the corresponding mean effective diameter approximated the MVD.

NACA also defined a "maximum diameter" intended to represent the largest droplets that were present in detectable quantities. This variable was not accurately measured with the available technique employing a single, 4 or 6 inch diameter cylinder covered with sensitized blueprint paper. Eventually, the use of maximum diameter was abandoned as unreliable (Lewis et al., 1947), (Lewis and Hoecker, 1949).

This idea of maximum diameter has been reinstated in the new Icing Data Base because of the accurate, high-resolution droplet size spectra that are now available with the modern, optical, droplet size spectrometers. Here, the term "maximum diameter" has been defined to mean the droplet size below which 95% of all the LWC is contained.

4. Altitude Above Ground Level (AGL) as a Preferred Altitude Reference

In the author's opinion, altitudes referenced to ground level are preferable to pressure altitude or altitudes referenced to sea level when analyzing cloud properties or specifying aircraft certification criteria limited to low or intermediate altitudes. There are two reasons for this preference. Firstly, cloud formation is more directly relatable to altitude AGL. That is, given the same initial conditions of temperature, relative humidity and lapse rate, a cloud that forms due to convection at 4000 ft AGL over Washington, D.C., would also form at 4000 ft AGL over Denver, Colorado. The fact that the elevation at Denver is 5000 ft above Washington, D.C. has no bearing on the formation or properties of the clouds. For this reason, when clouds or cloud properties are analyzed or otherwise grouped by altitude, it is more meaningful to use altitudes AGL. For example, if some cloud property such as maximum LWC were to be catalogued according to pressure altitude, then the LWC at altitudes only 2000 ft AGL over Denver would be unfairly compared with LWCs at altitudes of 7000 ft AGL over locations near sea level. Secondly, suppose that it were decided that a new set of certification criteria would be acceptable if flight under this certification were not to exceed 5000 ft. Obviously, if this were 5000 ft pressure altitude, then an affected aircraft could never leave the ground at Denver. On the other hand, a 5000 ft AGL limitation would correctly allow the subject aircraft to fly up to 10,000 ft pressure altitude over Denver without encountering overall cloud conditions any worse than at 5000 ft AGL anywhere else.

RESULTS

THE NEW ICING DATA BASE

1. The Data Management Philosophy

A major part of this research effort involved collecting, screening, and compiling both new and old data into a coded medium for automatic data processing. It was realized, for example, that in addition to the immediate aircraft icing application, a data base of the envisioned magnitude ought to be of value for basic cloud physics studies as well as for use in attempting to test or improve existing icing forecast rules. Thus, besides the principal variables of LWC, droplet size, air temperature, and horizontal extent, it seemed prudent to include other relevant information in order to ensure maximum usefulness of the data base. This information includes cloud type, cloud base and cloud top heights and temperatures, airmass type, geographic location, and a brief description of the synoptic situation at the location of the measurements. Some of these types of auxiliary information had been reported along with much of the NACA data.

The first problem was to condense large amounts of modern data into a manageable data base. Modern, electronically based probes and instrumentation provide digitized measurements at the rate of once every second or so during flight. Clearly, some kind of averaging scheme was required in order to avoid being overwhelmed by vast numbers of individual measurements. But averages over arbitrary intervals, such as for 1 minute periods or for an entire pass through a cloud, were undesirable because they would wash out useful detail otherwise available with the modern, high-resolution measurements. There was a need to define a suitable averaging scheme which would satisfy the following requirements:

- a) The averaging intervals should be short enough to resolve any significant changes in cloud characteristics along the flight path and represent natural variability without resulting in an unwieldy number of averages.
- b) Intervals of uniform, constant conditions within clouds should be preserved whole so their durations and characteristics can be documented without the ambiguity that would occur if the average included voids or adjacent parcels having significantly different, or variable properties.
- c) The scheme should resolve extremes of LWC and other variables without dilution.
- d) The scheme should preserve altitude dependent changes in cloud properties observed during ascents or descents through clouds.
- e) The scheme must be able to accommodate broken or scattered cloud conditions as well as widespread continuous clouds.
- f) The scheme must be compatible with the existing NACA measurements so they can be compiled and validly compared to the modern data.

Basically, the requirement is to divide the cloud into intervals where conditions are apparently different (or to group data into intervals where conditions are approximately constant).

After several ideas were tested, it was concluded that the most logical and practical approach was to average the measurements only over continuous, uniform portions of clouds or cloud parcels until any of several key variables changed significantly. If the aircraft were still in continuous clouds at that time, a new averaging interval was immediately begun and continued until the next significant change in cloud properties occurred. Otherwise, the next average was not begun until the aircraft entered another continuous, uniform section of cloud.

These averaging intervals are referred to as "icing events." The key variables and the amount of change in any of them that will signal the termination of an averaging interval (icing event) are given as "Rules for Defining Uniform Cloud Intervals" in Table 1.

There was still the need for a selection rule that would avoid swamping the data base with numerous, inconsequential cloud parcels or fragments, yet would not seriously bias the representativeness of the data at small values of LWC. The practical solution was to limit averages to clouds or cloud sections that are at least 1 nmi wide (20 s at true airspeeds of 180 kt) unless momentary LWCs were greater than 0.5 g/m^3 , or some other interesting property was worth documenting. This preserved extreme values of LWC associated with convective cells embedded in layer cloud systems, for example, but ignored brief cloud parcels in broken or scattered cloud systems with little vertical extent (and therefore with LWCs generally less than 0.1 g/m^3). These thin cloud layers are of little practical concern anyway, because they can be avoided in flight by minor changes in altitude.

Another advantage of the overall averaging scheme is that not only are data available on the extents of individual, uniform, cloud intervals, but the overall horizontal extent of continuous or semi-continuous icing conditions is available simply by summing the extent of consecutive events. (See later sections on Horizontal Extent for discussions of practical difficulties with this concept, however.)

Although these rules were designed for the modern data, the NACA data can be formally accommodated as well. The NACA measurements were timed exposures of rotating multicylinders in the airstream during flight through subfreezing clouds. The exposure times were usually 1 minute or more, and the data therefore represent an average over these intervals. The NACA data are published either as individual exposures or as averages of a group of exposures. Thus, there is no control over these intervals now, except to separate out from the groups the one exposure exhibiting the greatest average LWC, whenever that exposure was listed separately as well as being included in the average (Lewis, 1947).

2. The Data Coding Scheme

The means chosen for storing the data was the 80 column punchcard for computers. (Actually, a Hewlett Packard model 9825B desktop computer with cassette storage was used at NRL, but the 80 column format was retained

TABLE 1. RULES FOR DEFINING UNIFORM CLOUD INTERVALS

1. For Level Flight Through Continuous Cloud or Cloud Parcels 1 nmi or More in Extent.

RULES: LWC and other variables to be averaged over flight path in cloud until:

- A - Aircraft exits main cloud,
- B - Outside air temperature changes by $\pm 1.5^{\circ}\text{C}$,
- C - Outside air temperature rises above 0°C ,
- D - Droplet median volume diameter changes by $\pm 2.5 \mu\text{m}$,
- E - Aircraft changes flight levels by $\pm 500 \text{ ft}$ ($\pm 150 \text{ meters}$),
- F - Icing rate changes by $\pm 50\%$,
- G - Droplet concentration, N , changes by $\pm 50\%$ or ± 200 , whichever is less,
- H - Measurement arbitrarily terminated,
- J - Aircraft exits continuous cloud parcel,
- K - Subsequent cloud droplet probe data invalidated by snow or ice particles in cloud.

2. For Vertical Profiles in Continuous Cloud.

RULE: Report representative values of cloud variables for every 500 ft (150 m) change in altitude.

because of its universal compatibility.) The information associated with each icing event is coded on a separate card. All data cards for icing events from the same cloud or cloud system are grouped behind a lead card which contains general information, such as cloud type, cloud base height, etc., that applies to all of the data cards in the group. The code for assigning data to card columns is given in Table A-1 of Appendix A. Explanations and examples of each data item are given in Tables A-2 and A-3.

The entire Icing Data Base as of this writing is reproduced in Table A-4. It contains nearly 7000 nmi of icing events. It is anticipated that more data will be added in the future in order to better represent frontal, orographic, and lake effect clouds. Plans also call for the addition of data from Mt. Washington, New Hampshire, and foreign data as they become available.

The Mt. Washington data, though available, were not included in the Data Base at this time for several reasons. The principal reason was that it is not clear how to compare mountaintop, near-surface data with airborne measurements. That is, it is not clear how the Mt. Washington data apply to aircraft operations which normally do not take place close to the summit or sides of mountains in Instrument Meteorological Conditions (IMC). At best the Mt. Washington data could probably be used to represent worst case, orographically induced LWCs for locations with similar elevations and windward slopes. The other reasons for not using the Mt. Washington data were that, in the available form, the data bear no date or time of day information, nor do they indicate the cloud type or synoptic weather category involved.

'DATA MILES' AS A MEASURE OF FREQUENCY OF OCCURRENCE

During the early phases of this project, it became clear that usage of "number of cases" or "number of events," as is conventionally done to represent the frequency of occurrence of any of the variables, was unsatisfactory. The deficiency was twofold. Firstly, momentary icing events would incorrectly carry just as much statistical weight as long-lasting events. Thus, there was no way to emphasize the statistical importance of an extended encounter with an extreme value of LWC, for example, compared to a relatively insignificant, brief encounter. Secondly, the reader would have no information as to whether a given number of events represents 5 miles or 500 miles of in-flight measurements.

"Data miles" were therefore chosen as the most informative measure of frequency of occurrence. The term is defined as the distance flown in nautical miles during an individual icing event (during an actual probe exposure for the NACA measurements). This convention automatically weights each icing event (or measurement of LWC, for example) by its duration or extent. The other principal advantage is that the reader can easily judge the statistical significance of a data set by the number of data miles it represents.

Duration in terms of distance rather than time was chosen because time duration is not as easy to standardize. The time duration of an event depends on the speed of the aircraft which makes comparison of the data somewhat ambiguous. However, for those purposes where it may be of interest, the time duration of each event is coded in columns 10-11 of each of the icing event data cards.

REVIEW OF THE NACA DATA

An interim report on this project (Jack, 1980) gave an assessment of the NACA data, reported detailed results from the initial NRL research flights, and gave a preliminary comparison of the NRL measurements with the NACA data. The principal conclusions of the NACA review are as follows:

- a) A large fraction of the NACA measurements was actually obtained at altitudes below 10,000 ft.

- b) All synoptic conditions and cloud types appear to have been sampled but the number of data miles is small in some categories, especially frontal zones (see Appendix B, Table B-3).
- c) Of the several measurement techniques that were tried, the NACA researchers regarded the multicylinder probes to be the most accurate and reliable for deducing LWC. They were eventually aware, however, that their measurements and computations of LWC were subject to at least 13 possible sources of error (Lewis and Bergrun, 1952, p. 16) some positive, some negative, and ranging in magnitude from a few percent up to possibly 100% or more. The net effect of all these possible sources of error is uncertain in the data as reported, but general agreement is found between the NACA data and the modern data. In the detailed comparisons there are also some remarkable similarities, but some differences too, as is shown in the remainder of this report.

The principal problems faced by the NACA researchers were the following:

In 1952, after the NACA researchers became aware of the seriousness of runoff errors for measurements at temperatures just below 0°C, they reexamined their data and concluded that not more than about 5% of the reported measurements would be affected (ibid.). A more significant problem may have been the underindication of average LWC from measurements where the multicylinder probe was exposed in clouds containing momentary voids. In order to correct for this, some of the NACA flights made use of a continuously recording, rotating-disk probe, or "cloud indicator" to document the actual duration of clouds and voids during exposure of the multicylinder probes. As a result, significantly larger values of average LWC were obtained in some cases when the more accurately determined cloud exposure intervals were used (Lewis and Hoecker, 1949, Table 1).

Droplet size distributions were finally given up as totally unreliable when NACA researchers concluded in 1949 that there were too many contradictions in droplet sizes as inferred from the multicylinder probes vs. the coated, fixed-diameter cylinder probes (ibid., p. 1, p. 16). However, the median volume diameters inferred from the multicylinder method alone were still regarded as accurate for "small" droplets but became increasingly inaccurate as the drop size increased. Also, large overestimates were more probable than large underestimates, especially at large values of droplet diameter (Lewis and Bergrun, 1952, p. 17).

ANALYSES AND COMPARISON OF THE NACA AND MODERN DATA

1. At What Altitude Do Icing Conditions Become Serious?

a. Maximum LWC vs. Altitude

A stated goal of the present study is to characterize the icing hazards in the atmosphere from sea level up to 10,000 ft above sea level (ASL). The magnitude of the LWC in supercooled clouds is one of the most important factors in assessing the potential severity of aircraft icing. In order to

examine the dependence of LWC on altitude AGL, LWC data were sorted by altitude into the ten 1000 ft intervals between ground level and 10,000 ft AGL. Within each altitude interval, the LWC values were ranked according to cumulative frequencies of occurrence (i.e., the number of data miles accumulated with LWCs up to and including a given value of LWC). One can then determine the LWC values which represent the upper limit of occurrence for selected percentiles of the data miles. The results of such an analysis are shown graphically in figures 7 and 8 for the NACA and modern data, respectively.

A comparison of these two plots shows gross similarities in the altitude dependence of maximum LWC. In both plots the overall maximum observed LWC occurs between the altitudes of 7000 and 9000 ft AGL and has a value of 1.5 to 1.7 g/m³; the maximum LWC then decreases with altitude up to 10,000 ft. This latter result is probably due to deficient sampling in convective clouds with the low bases and larger vertical extents that are needed to produce supercooled LWCs greater than 1.5 g/m³ at altitudes above 8000 ft AGL. These convective clouds are scarce during the winter months during which most of the flight data were obtained. In the warmer months the freezing level is frequently above 10,000 ft AGL in clouds of the required depth and therefore larger values of supercooled LWC are still difficult to obtain at altitudes below 10,000 ft.

There are also comparable secondary maxima in both figures 7 and 8, one at the altitude intervals of 4000 to 6000 ft AGL and one at about 2000 ft AGL. The 4000 to 6000 ft AGL interval presumably corresponds to typical upper limits of the turbulent mixing layer in many wintertime situations. The base of the turbulent or subsidence inversion that resides in this altitude interval blocks the vertical development of the stratus or stratocumulus that forms underneath as a result of turbulent mixing. It is known that the maximum LWC developed within a cloud layer generally lies just below cloud top and depends in magnitude on the vertical thickness of the cloud layer. Thus the maximum LWCs will be found just below the turbulent or subsidence inversion whose upper limit appears to be at about 6000 ft AGL.

Percentile curves cumulative with altitude for the entire CONUS Data Base are given in figure 9.

b. Horizontal Extent of Icing Encounters vs. Altitude

These conclusions are further substantiated by figures 10 to 13 where the altitude dependence of horizontal extents of extended icing encounters has been plotted. Again, the NACA and modern data show some surprising similarities. In figure 10 the horizontal extent of the NACA layer cloud icing is seen to peak sharply at an altitude of about 4000 ft AGL. The modern data, figure 11, show a similar, but broader peak which spreads over the range of about 3000 to 5000 ft AGL. At about 8000 ft AGL the modern data show a second, sharper peak which does not appear in the NACA data. These horizontal extents for layer clouds indicate that the top of the turbulent mixing layer in wintertime stratus-forming conditions lies between 3000 and 5000 ft AGL.

The horizontal extents of extended icing encounters in convective clouds are considerably shorter and peak at altitudes above 5000 ft AGL as shown in

figures 12 and 13. In these cases, one can also see remarkable similarities between the old and new results. Both show a double peak in horizontal extent with one sharp peak at about 8000 ft AGL and another peak, though poorly resolved in the NACA data, at about 6000 ft.

One question that is prompted by these considerations is whether there exists any "threshold" height above which icing conditions rapidly worsen. If such a threshold does occur, then it may be of practical importance to limit certification to altitudes below it. The altitude dependences of LWC and horizontal extent shown in figures 7 to 13 do not answer this question unambiguously. For example, if the 99th percentile curve is chosen as a guide, figures 7 and 8 show that LWC increases most rapidly between 4000 and 6000 ft AGL for both the NACA and modern data. At 4000 ft AGL the LWC is expected to be less than 0.6 g/m^3 for 99% of the miles flown in icing clouds. This 99% value doubles in the next 2000 feet to about 1.2 g/m^3 at 6000 ft AGL. This suggests that 4000 ft AGL should be considered as a threshold level above which icing conditions rapidly worsen.

On the other hand, figures 10 and 11 show that, in terms of the horizontal extent of extended icing conditions, flight levels of 3000 or 4000 ft AGL are already in a region of maximum horizontal extent. If half the maximum horizontal extent is used as a guide in this case, then about 2000 ft AGL should be considered as the threshold or limiting altitude according to the modern data in figure 11.

c. Altitude Dependence of Average Ice Accretion per Icing Encounter

Rather than relying on LWC or horizontal extent individually, a better indicator of icing severity would be the altitude dependence of the average ice accretion per icing encounter. This quantity is basically just the mass of ice accreted per unit area on an object moving at velocity V for a time t through a cloud with supercooled liquid water content W , as given by the equation

$$M = EWVtF \quad (1)$$

where E is the collection efficiency of the object (wing section, rotor blade, etc.), and F is the freezing fraction which is assumed to be equal to unity here. The collection efficiency depends on the shape of the object and is also approximately a logarithmic function of the airspeed and the droplet diameter (Brun et al., 1955). For the present purposes, E can be taken as unity, or at least as approximately constant. Also note that the product Vt is just the horizontal extent, H , of the extended icing encounter so that Eq(1) reduces to $M = WH$. The altitude dependence of this product is plotted in figures 14 to 16. According to the NACA data in figure 14 the maximum ice accretion is reached at about 4000 ft AGL. In the modern data, figure 15, the maximum does not occur until 8000 ft AGL but that is of little significance since 80% of maximum is reached at altitudes as low as 3000 ft AGL. The combined effect of both data sets is shown in figure 16 where it is seen that above 2000 ft AGL, altitude makes practically no difference on the amount of ice accretion to be expected.

2. LWC Frequency of Occurrence Over the Entire 0 to 10,000 ft AGL Range

The frequency of occurrence of individual LWC values is shown in figures 17 to 19 for the entire altitude range up to 10,000 ft. The ordinate in each of these graphs is the total number of data miles flown in icing events with the observed LWC falling in the corresponding 0.1 g/m^3 wide interval along the abscissa. No distinction is made between layer and convective clouds in these graphs.

Note that the shape of the histograms is similar for the NACA and the modern data. The mode of the distributions is also seen to lie in the second LWC interval instead of the first. This result is no doubt an artifact due to the natural bias on the part of icing researchers against recording barely perceptible icing encounters, especially when the more severe conditions are of principal interest. Although it has little significance for the present purposes, a truly accurate LWC frequency distribution curve would continue to rise, probably more or less exponentially, for values of LWC approaching zero.

3. LWC vs. Median Volume Diameter (MVD)

Surprisingly, it is found that when either the NACA or modern data for individual icing events are plotted in the LWC vs. MVD format of the FAR-25, Appendix C icing envelopes, most of the datum points fall outside to the left of these envelopes! This result is exemplified in figure 20 for layer clouds. The questions that immediately arise are: how were the envelopes and their boundaries originally derived, and why were the MVDs cut off at $15 \mu\text{m}$ rather than being extended to smaller diameters?

Origins of the "Icing Envelopes" in FAR-25, Appendix C

Information printed on figures 1 and 4 of FAR-25, Appendix C states that NACA report TN-1855 (Jones and Lewis, 1949) is the source of data for these envelopes. Within TN-1855 the reader is referred to two earlier reports, TN-1393 (Lewis, 1947) and TN-1424 (Lewis et al., 1947) for the actual data on which the "continuous maximum" envelopes are based. Both TN-1393 and TN-1424 show numerous observations of MVDs in the range 7 to $15 \mu\text{m}$. In fact, figure 6 of TN-1424 contains a probability curve which shows that 50% of the observed MVDs are smaller than $13 \mu\text{m}$! None of these references contain any obvious statements that $15 \mu\text{m}$ was viewed as the minimum MVD worth consideration. However, such conclusions may have arisen implicitly from the discourse in TN-1393 on the subject of icing forecast problems. On page 16 of that report, it is proposed that a fixed MVD of $14 \mu\text{m}$ be assumed for layer clouds in order to simplify the problem of specifying icing intensities from a knowledge of cloud type and estimated LWC alone. Also, in a later section (page 22 of TN-1393) dealing with maximum, continuous LWCs that are likely to occur in layer clouds, a value of $15 \mu\text{m}$ is proposed as a reasonable estimate for MVDs to be expected concurrently with continuous maximum LWCs of 0.8 g/m^3 . The authors then point out that LWCs of 0.5 g/m^3 along with MVDs of $25 \mu\text{m}$ should be considered as a definite probability in layer clouds too. These conclusions, coupled with a recollection (page 7 of TN-1393) that severe icing was observed on the windshield of their C-46 research aircraft with only 0.15 g/m^3 of LWC when the MVD was an unusually large $50 \mu\text{m}$, apparently led the

author to stress the potential importance of the larger MVDs because of the greater collection efficiencies associated with them.

It is suggested here that for the purposes of helicopter icing concerns, MVDs smaller than $15\text{ }\mu\text{m}$ should also be considered because the thin rotor blades are expected to have significant catch efficiencies for these smaller droplets as well.

4. Implications of the NACA Data Replotted

One question to be addressed by this research project is whether or not a single icing envelope can be devised to replace the two currently in use (the "continuous maximum" and "intermittent maximum" of FAR-25, App. C.), if certification is limited to some maximum altitude at or below 10,000 ft. That is, for altitudes below a certain level there may be little difference between layer and convective type clouds, as far as LWC is concerned. In order to determine the feasibility of this approach, first the NACA data and then the modern data will be analysed by cloud type.

a. Supercooled Layer Clouds Below 10,000 ft AGL

Figure 20 contains the NACA data for layer clouds at altitudes up to 10,000 ft AGL and for ambient temperatures from -10° to 0°C . Data for temperatures between -20° and -10°C are plotted in figure 21. There are practically no NACA data reported for temperatures below -20°C at altitudes below 10,000 ft AGL. By comparing figures 20 and 21, one may note that maximum LWCs are indeed decreased at the lower temperatures, but only for MVDs smaller than about $25\text{ }\mu\text{m}$. Data are sparse at all temperatures for MVDs greater than $25\text{ }\mu\text{m}$, but of the data that do exist above $25\text{ }\mu\text{m}$, maximum LWCs appear to be generally greater in the temperature range -20° to -10°C than in the range -10° to 0°C .

It is of interest at this point to ask what kind of clouds or situations are associated with these larger MVDs in the NACA data. An examination of the Icing Data Base reveals that 9 out of the 13 events having MVDs greater than $30\text{ }\mu\text{m}$ are reported to be from altocumulus clouds. Eleven of these 13 events occurred in maritime polar (mP) air masses, and all except two or three occurred within 200 miles of a low pressure center or less than 200 miles behind a surface cold front. Nearly all MVDs greater than $30\text{ }\mu\text{m}$ occurred at altitudes above 5000 ft AGL. Half of these cases occurred in the presence of snow, while the other half had no precipitation information so that the presence of any precipitation is unknown. It is suggested later in this report that MVDs in excess of $35\text{ }\mu\text{m}$ are probably artifacts.

b. Supercooled Convective Clouds Below 10,000 ft AGL

Figure 22 contains the NACA data for convective clouds penetrated at altitudes below 10,000 ft AGL and for air temperatures from -10° to 0°C . Additional events recorded in air temperatures between -20° and -10°C are plotted in figure 23. It is obvious that there were many more data miles logged by NACA in layer clouds than in convective clouds below 10,000 ft. This is a natural result of the infrequent occurrence of convective systems in winter months--the time of year that the icing research flights took place.

5. Implications of the Modern Data

a. Supercooled Layer Clouds Below 10,000 ft AGL

Figure 24 contains the available modern data from layer clouds at altitudes up to 10,000 ft AGL and at temperatures from -10° to 0°C . Additional data are plotted in figure 25 for clouds at temperatures between -20° and -10°C , and in figure 26 for temperatures below -20°C . It is noted that the modern data exhibit a significant decrease in maximum observed MVDs at the lower temperatures, a trend not found in the NACA layer cloud data. The maximum MVDs retreat to below $15\text{ }\mu\text{m}$ at temperatures below -20°C . The main features common to both the NACA and modern CONUS data for layer clouds are the gradual decrease in maximum LWC with decreasing temperature, the concentrating of MVDs between 5 and $15\text{ }\mu\text{m}$, the peaking of maximum LWCs at MVDs between 10 and $15\text{ }\mu\text{m}$, and the infrequent occurrence of MVDs larger than about $30\text{ }\mu\text{m}$.

b. $35\text{ }\mu\text{m}$ as the Upper Limit to MVDs for Cloud Droplets in Supercooled Layer Clouds at Altitudes Below 10,000 ft AGL

Researchers using the Particle Measuring Systems' (PMS) cloud droplet probes have found that indicated MVDs larger than about $35\text{ }\mu\text{m}$ are usually identifiable as artifacts resulting from the erratic response of the ASSP or FSSP cloud droplet size spectrometers to snowflakes or other ice particles. These faceted particles apparently cause spurious reflections of the particle-illuminating laser beam into the photodetector in these probes. The effect is usually evident as a random distribution of counts appearing throughout the entire particle size range to which the probe is sensitive. It is also found that these large MVDs are always associated with small droplet concentrations, usually less than 50 per cubic centimeter. This observation may be an indication of the fact that, in the presence of ice particles or snowflakes, cloud droplets tend to evaporate and the released water vapor redeposits on the snowflake population. However, the radius-cubed dependence of droplet mass or volume allows the few spurious counts in the larger particle size channels of the PMS probes to dominate the LWC computations and thereby strongly bias the indicated MVD to unusually large values.

It may be possible that MVDs larger than $35\text{ }\mu\text{m}$ actually occur in some portions of vigorously convective clouds; for example, some of the University of Wyoming data over the windward slopes of the Sierra Nevada mountains, but MVDs larger than $35\text{ }\mu\text{m}$ do not appear to be unambiguously present in supercooled layer clouds. Other large droplets, such as drizzle, cannot account for such large MVDs in supercooled clouds. Drizzle occurs in clouds only at temperatures above freezing, since these droplets are actually melted snowflakes or melted ice particles when they are associated with wintertime cloud systems. The only time these precipitation droplets are encountered at subfreezing temperatures is in the case of freezing rain or freezing drizzle where the droplets fall from warm clouds above an overlying warm frontal surface into a cold air mass below.

The modern data have all been screened in an attempt to eliminate ASSP or FSSP droplet size spectra which are obviously contaminated by snowflakes. The screening process is a bit subjective, however, and some cases are difficult to judge when the data source contains no visual accounts of in-cloud

conditions and no information on the presence of precipitation at the time of the measurements. Cases in point are the three MRI icing events plotted in figure 24 with MVDs of 29, 31 and 32 μm . All three of these came from the same flight and cloud and are suspected of being influenced by snow or ice crystal artifacts, but no information about cloud conditions or precipitation is reported that would positively invalidate these MVDs.

The NACA MVDs larger than 30 μm are suspected of being grossly overestimated due to serious inaccuracies in the determination of large MVDs from rotating multicylinder data (Lewis and Bergrun, 1952, p. 17; Brun et al., 1955, p. 29). The error analysis of Brun et al., as summarized in their figure 27, shows that: at an airspeed of 200 kt, and with an error of $\pm 5\%$ in rotation multicylinder measurements, a derived MVD of 30 μm , the largest MVD considered in their error analyses, may be overestimated by as much as 35% or underestimated by up to 18%. Overestimation of the true MVD is more probable than underestimation. For an error of $\pm 10\%$ in multicylinder measurements, the uncertainty in a 30 μm MVD assignment is $\pm 70\%$, -27% . In any case, the rate of increase in the uncertainty is so great at 30 μm that MVD assignments larger than 30 μm appear to be out of the question.

c. Supercooled Convective Clouds Below 10,000 ft AGL

Figure 27 contains the data from convective clouds penetrated at altitudes up to 10,000 ft AGL and at temperatures between -10° and 0°C . Additional events recorded in air temperatures between -20° and -10°C are plotted in figure 28. These data compare favorably with the NACA data in figures 22 and 23 although the maximum LWCs are considerably larger for the modern data in the -10° to 0°C temperature range than they are for the NACA data. There were no occurrences of convective clouds at temperatures below -17°C at altitudes below 10,000 ft.

6. Temperature Dependence of Cloud Height, LWC and MVD

a. Temperature Dependence of Cloud Height and Occurrence

The distribution of supercooled layer cloud temperatures versus altitude AGL is given in figures 29 and 30 for the modern and NACA data sets, respectively. Interestingly, the coldest layer clouds were not found at 10,000 ft AGL, but at intermediate altitudes that were rather similar for both data sets. The data suggest that for temperatures below -15°C there is both a lower and upper limit to altitudes AGL at which layer clouds at these temperatures will be easily found. The lower the cloud temperature below -15°C , the narrower the permissible altitude range will be. For icing certification flights, the message is that the coldest layer clouds will most easily be found from 4000 to 6000 ft AGL. Examination of these low temperature records in the Data Base revealed that for both the NACA and modern data these coldest layer clouds occurred in the vicinity of the Great Lakes in January. These findings are examined in more detail in Appendix C.

The altitude distribution of supercooled convective cloud temperatures, figures 31 and 32, is different in at least two respects. One is that supercooled convective clouds colder than about -17°C have not been found at altitudes below 10,000 ft AGL. Secondly, there is an obvious and more

consolidated upward trend in altitude AGL as one goes to lower cloud temperatures. This trend is again similar in both the NACA and modern data.

b. Temperature Dependence of Maximum Supercooled LWC by Cloud Category

Scatterplots of observed LWC vs. OAT at flight level are given in figures 33 and 34 for layer clouds in the modern and NACA data sets, respectively. Although there is a general decrease in maximum LWC with decreasing temperature, the trend shown by the data sets taken separately is by no means uniform. When the NACA and modern data sets are combined (not shown), however, a more uniform trend becomes apparent. The combined data sets should serve as a good basis for reexamining the probabilities of exceeding given values of LWC as a function of temperature for layer clouds. The solid line bounding the data points in figures 33 and 34 represents the maximum observed and expected LWC for CONUS based on the combined CONUS data set.

Figures 35 and 36 contain scatterplots of LWC vs. OAT for supercooled convective clouds below 10,000 ft AGL. The NACA and modern data are shown separately for comparison purposes but, as before, the combined data set reveals a clearer limit to the maximum LWC as a function of temperature. The apparent limit is represented by the solid line in figures 35 and 36. The slope of this limiting line is markedly steeper than for layer clouds.

The absence of observed LWCs above 0.6 g/m^3 in the NACA data (figure 36) at temperatures above about -7°C is due partly to the progressive failure of the ice accretion technique for measuring increasingly large LWCs at temperatures only a few degrees below freezing. This is the well-known "runoff" problem where, for a given temperature, there is a limit to the LWC that can be intercepted by the probe without some of the supercooled water running off or blowing off before it has time to freeze to the probe (Ludlam, 1951; Kleutens et al., 1977).

The modern measurements use hot wire devices and laser based probes for indicating LWC and therefore they do not have this problem. For the modern data (figure 35), the shortage of LWC values greater than 1.3 g/m^3 at temperatures above -10°C is probably due to the shortage of flights into large convective clouds with low, warm bases and with freezing levels that are high but still below 10,000 ft AGL. Such clouds typically occur in the springtime months.

Clouds with sufficiently deep extent below the freezing level could produce supercooled LWCs greater than 1.3 g/m^3 , but freezing levels in the vicinity of 8000 ft AGL or higher would probably be required. This situation is of little concern for present purposes, assuming that helicopters or other light aircraft of interest would stay below a high freezing level in the presence of clouds anyway, or would at least avoid such large and obvious convective buildups as a normal precaution for avoiding possible turbulence, lightning, or hail.

The Data Base, as it currently stands, represents the general wintertime climate where freezing levels are well below 10,000 ft AGL, such that flight above the freezing level cannot generally be avoided.

Selected percentiles of LWC occurrences cumulative in each of the 5°C temperature intervals are plotted in figure 37. It is seen again, that for convective clouds, the observed maximum LWCs occur between -5° and -10°C or -10° and -15°C, depending on the percentile curve of interest. It must be remembered that the Data Base represents the typical wintertime environment with relatively low freezing levels. It does not include conditions in the interior of atypical, deep convective buildups having low, warm bases and potentially large LWCs above an elevated freezing level near 10,000 ft AGL.

c. Temperature Dependence of Extreme MVD by Cloud Category

The variation of extreme values of MVD vs. OAT is somewhat more complicated than for LWC. Figures 38 and 39 contain scatterplots of MVD vs. OAT for supercooled layer clouds from the modern and NACA data sets, respectively. The two data sets are not in very good agreement. For temperatures increasing above -15°C the modern data show an increase in maximum MVD up to a limiting value of about 35 μm as discussed earlier in this report. The NACA data set contains about a dozen MVDs between 35 and 50 μm at temperatures above -15°C, but these large MVDs are subject to considerable overestimation as described earlier. The solid lines drawn on figures 38 and 39 show the proposed dependence of maximum MVD vs. OAT for supercooled layer clouds below 10,000 ft AGL.

Figures 40 and 41 show scatterplots of MVD vs. OAT for convective clouds. In this case, both the NACA and modern data are in agreement and exhibit a trend that is just the opposite of that for layer clouds. That is, MVDs in supercooled convective clouds tend to increase with decreasing temperature. In fact, there is not so much of a change in maximum MVD with temperature as there is an apparent increase in minimum MVD with decreasing temperature! Also note that, except for two maverick MVDs at 45 μm in the NACA data set, all of the supercooled convective cloud MVDs are less than 35 μm .

7. Average Values of MVD by Cloud Category

Over the entire supercooled temperature range of 0° to -30°C and for altitudes up to 10,000 ft AGL, both the modern and NACA data sets agree that 18 μm is the average MVD for convective clouds. For layer clouds, the average MVD is 13 μm according to the modern data and the NACA data are in close agreement with an average of 14 μm .

HORIZONTAL EXTENT

1. Ambiguities in the Meaning and Measurement of Horizontal Extent

The term "horizontal extent" does not have a consistent, precisely defined meaning in the literature on aircraft icing. One usage indicates the distance flown during a given measurement interval until a cloud gap of some specified duration signals the end of the interval (Lewis and Hoecker, 1948, p. 3). Another, less precise usage occurs when statistically processed data are to be interpreted for engineering design purposes. An example is the problem of determining the probable maximum average LWC as a function of flight distance (horizontal extent) in general icing conditions (ibid., p. 9,

37). This usage is implied by the "horizontal extent" curves of FAR-25, App. C. There is no specification of allowable discontinuity to the icing conditions, or how large and frequent any cloud gaps may be. Even the measurement interval usage has not seen consistent specifications for allowable cloud gaps, which have run from 10 s (0.5 nmi at 180 kt) (ibid., p. 3) to 10 min. (30 nmi at 180 kt) (Perkins, 1959, p. 6). "Horizontal extent" does not seem to be used as a measure of the overall dimensions of wintertime cloud systems throughout which icing conditions can be expected.

In practice, values of horizontal extent associated with airborne measurements are more determined by the choice of sampling maneuvers and flight path than they are a description of the actual geographic extent of clouds and icing conditions. This is true of both the NACA and modern research flights where repetitive passes at different altitudes through the same cloud or cloud system are often executed. Otherwise, the choice of destinations, available flight time, and air traffic restrictions, strongly influence the ability of any research flight to pursue extended, unidirectional measurements in preferred directions and at preferred altitudes.

In order to clarify the usage as much as possible, we distinguish between two meanings of the term as applied in this report. One usage applies to the duration of individual icing events. The other applies to the sum of a number of icing events which together constitute an icing "encounter." The "encounter" is conceptually the same as the gap-delimited icing interval. The extent of an encounter is defined here as the total extent of a series of icing events consecutively penetrated until a gap of a stated, but selectable length is experienced. Accordingly, even though the values of LWC, MVD and other variables may differ from one event to another during the encounter, the aircraft experiences measurable icing conditions throughout, except for allowable gaps. The horizontal extent of individual icing events is probably of greater interest for cloud physics studies per se, while the icing encounter is probably more relevant to aircraft icing concerns.

2. Horizontal Extent of Individual Icing Events

The NACA data have been processed so that the "horizontal extent" of individual icing events (columns 12-13 in the Icing Data Base) is simply the distance flown during actual exposure of the multicylinder probes. These distances are computed from the reported values of true airspeed, individual exposure time, and the number of exposures represented in the reported LWC averages. Flight distances between individual exposures, even within the same averaging interval, are not counted. This convention permits the NACA data to be compared with the modern data since the basis of measurement, i.e., discrete exposure intervals, is then the same.

The extents of individual icing events have been plotted against LWC in figure 42 for the NACA data and figure 43 for the modern data. An inverse relationship is evident between LWC and the longest horizontal extents observed at any given value of LWC. This is a well-known result and is reflected in the "horizontal extent" curves of FAR-25, App. C. The NACA horizontal extents also show a notable bifurcation or double valuedness which does not appear in the modern data. This bifurcation is probably an artifact resulting from the grouping of measurement exposures by the NACA researchers.

The upper branch of the bifurcation consists of data points clustered along a line from about 18 nmi horizontal extent at a LWC of 0.4 g/m^3 to about 2 or 3 nmi for the largest values of LWC observed. These terminal values of horizontal extent are consistent with the standard horizontal extents of 17.4 nmi and 2.6 nmi specified in FAR-25, App. C for the Continuous Maximum and Intermittent Maximum criteria, respectively.

At this point, it is of interest to find out what conditions produced the extreme horizontal extents for the NACA data points labeled a through f in figure 42. A consultation of the original NACA publications revealed that only data point f was a single, 5 minute exposure within one cloud. The other data points in question represent from 12 to 25 exposures each! Thus it seems likely that at least the data from the CuCb clouds (data points "b" and "e") represent several passes through the cloud. Data points marked "a", "c", and "d" are from St, St or Sc, and As clouds, respectively and may have been unusual opportunities for long-duration sampling.

3. Horizontal Extent of Icing Encounters

In accordance with our definition stated above, the extents of entire "encounters" have been constructed from the Icing Data Base by adding horizontal extents of individual, consecutive, icing events until a specified cloud gap interval is experienced. Figures 44, 45, and 46 show the results for modern data up to 10,000 ft AGL where the maximum allowable cloud gaps are 1, 3, and 10 nmi, respectively. The horizontal extent for the encounter has been plotted against the overall average LWC for the encounter. The choice of cloud gap interval makes some difference for LWCs less than 0.4 g/m^3 but has little effect on encounters with larger LWCs. That is, icing events with large LWCs are not only less frequent but they are of short duration as well. They therefore add little to the horizontal extent of any encounter.

The published NACA data consist both of individual samples obtained miles apart in the cloud or cloud system and groups of samples already combined into an average LWC for the group. The large separations between the individual samples preclude their inclusion into larger encounters, as defined above. The existing groups cannot be further resolved into individual samples, except for some cases (Lewis, 1947) where the one sample having the greatest LWC of the group is listed separately. As a result, the NACA horizontal extents are already "locked in" and plots (not shown) of data for encounters with gaps up to 10 nmi are identical with those in figure 42.

4. Considerations for Horizontal Extent

In order to correct the discrepancy that currently exists in the meaning of horizontal extent, it is suggested here, that, for helicopter applications, at least, "horizontal extent" be linked to definable icing encounters for engineering design purposes. This would simplify the conversion of measurement data into design criteria. Icing encounters are defined by the maximum distance (gap) allowed between individual icing events or continuous icing intervals. A standard value of maximum, allowable, gap distance could be specified by the regulating agency. This would then permit an unambiguous determination of maximum horizontal extents from basic data, such as in figures 44 to 46.

Considering the NACA data alone, one could construct on figure 42 a smooth curve representing the average maximum observed horizontal extent as a function of LWC for encounters separated by gaps of 10 nmi or less. The curve could be determined, for example, by averaging the data points along and above the upper branch of the bifurcation for each increment in LWC. Such a curve for altitudes up to 10,000 ft AGL would range from about 20 nmi at 0.1 g/m^3 to about 5 nmi at 1 g/m^3 .

The modern data more realistically exhibit longer maximum horizontal extents for LWCs less than 0.3 g/m^3 . A smooth, or average curve representing some specified, cumulative frequency of occurrence value for horizontal extent vs. LWC could serve as a workable criterion for a specified maximum allowable gap distance. For example, the 99th percentile value of horizontal extent (i.e., the value of horizontal extent which is unexceeded 99% of the time) computed from the Data Base for each 0.1 g/m^3 LWC interval is shown superimposed on the scatterplots in figures 44 to 46.

CONCLUSIONS

The reader is cautioned to keep in mind the important fact that the conclusions presented here are based on data only in clouds at temperatures below 0°C and for altitudes below 10,000 feet AGL and 12,000 feet ASL. The reader is referred to the Executive Summary at the beginning of this report for the principal conclusions relevant to aircraft icing certification. Additional conclusions are given below.

1. Conclusions Based on Graphs and Analyses Detailed in this Report.

a. Supercooled LWCs up to 1.7 grams per cubic meter (g/m^3) have been found, but 99% of the observed values are less than 1.1 g/m^3 and 95% are less than 0.6 g/m^3 for all cloud types. The largest LWCs occur in convective clouds, cumulus (Cu) and cumulonimbus (Cb) usually within 100 to 300 nmi behind a cold front in maritime air masses, and especially in connection with orographic uplifting along the western slopes of the Cascade mountain range in California (and probably in Washington and Oregon as well). Except for these orographic influences, supercooled convective clouds are rare below 5000 ft AGL. Supercooled LWCs greater than the observed maximum of 1.7 g/m^3 may be possible below 10,000 ft AGL in deep convective clouds with bases which are relatively warm and below 4000 ft AGL. For example, given a freezing level at 9000 ft AGL and cloud base at 3000 ft AGL ($+10^\circ\text{C}$), computations show that the practical maximum (i.e., two-thirds of the theoretical maximum) LWCs are 2.0 g/m^3 and 2.2 g/m^3 at 9000 ft and 10,000 ft (-2°C), respectively. Conditions approximately matching these simultaneous requirements of deep convective cloud with base below 4000 ft AGL and freezing level near 10,000 ft AGL appear to be rare however, and no instances have been recorded in the Data Base.

b. The rate of decrease of maximum observed LWC with decreasing temperature at altitudes below 10,000 ft AGL appears to be about 0.2 g/m^3 per degree C for convective clouds and about 0.04 g/m^3 per degree C for layer clouds (see figures 33 to 36).

c. Average median volume diameters (MVDs) for cloud droplets in layer and convective clouds are about $13 \mu\text{m}$ and $18 \mu\text{m}$, respectively, when measurements at all temperatures between 0° and -25°C are lumped together.

d. Horizontal extents are altitude dependent and preferred altitudes appear at 4000 to 6000 ft AGL and again at about 8000 ft AGL. Maximum LWCs are also variable with altitude and the average LWC increases slowly with increasing altitude AGL. However, the average value of the product of LWC and horizontal extent is practically independent of altitude between 2000 and 10,000 ft AGL. This latter result indicates that the average ice accretion to be expected per icing encounter is independent of altitude over this same 2000 to 10,000 ft range (see figure 16).

e. When all supercooled cloud data are considered together, the extreme values of LWC and MVD are approximated by the curves shown in figure 47 for three significant temperatures. The curve corresponding to -20°C reflects the abrupt drop in MVD which occurs at about -17°C when contributions from convective clouds (Cu, Cb) drop out. Convective clouds below 10,000 ft AGL do not appear to exist at temperatures below about -17°C . Figure 47 better

represents the icing environment at altitudes up to 10,000 ft AGL than do the Continuous Maximum and Intermittent Maximum envelopes of FAR-25, Appendix C (see figures 1 and 4 of this report).

2. Conclusions Substantiated by the Icing Data Base but not Detailed in this Report.

a. Missing Data

Icing clouds closely associated with frontal wave cyclones, deep low pressure centers or winter storms, and strong lake effect situations are still not well represented in the Icing Data Base. Data are also scarce specifically for cases of very low ceilings. When an airfield has "gone IFR" (i.e., the local ceiling is 1000 ft or less and the local visibility is one mile or less) and the freezing level is near or below cloud base, then any aircraft that takes off or lands at that location can hardly avoid icing conditions. This type of weather condition is probably one of the greatest concerns to helicopters because the ceiling is too low to fly under, considering ground clearance requirements in most areas over land. Most of the cases of low ceiling and low freezing level in the Washington, DC area during the winter of 1981-82 were associated with the widespread cloudiness of frontal wave cyclones. This again emphasizes the need to obtain a representative amount of airborne measurements in these low pressure, low ceiling situations.

Data on freezing rain or freezing drizzle are essentially absent from the Icing Data Base at this writing.

b. Geographic Variations

Helicopters, whose flights are confined to certain geographic areas, may experience a frequency distribution of LWC that is markedly different from those shown in figure 19 which is an amalgam of all cloud types, synoptic and mesoscale conditions, and geographic locations. For example, helicopters servicing oil rigs offshore from the middle Atlantic and New England states would encounter extensive stratocumulus forming offshore during cold air outbreaks (Ludlam, 1980, plate 7.10). A study of the cloud cover imagery from the GOES-East meteorological satellite shows frequent occurrences of persistent stratocumulus formation in these offshore areas during the winter of 1981-82. The one NRL research flight that sampled these clouds at a location offshore from Cape Hatteras, North Carolina, recorded LWCs up to 1.2 g/m^3 at altitudes of 6000 to 7000 ft ASL. Of course, since the cloud base at that location was about 3400 ft these clouds could have been easily avoided by any aircraft. But the point is that certain geographic areas, particularly the offshore and mountainous areas, are scenes of peculiar synoptic scale or mesoscale effects which can significantly increase the possibility for encountering values of LWC that are in the upper reaches of the distribution curve.

3. Conclusions Based on In-Flight Observations and Experience

a. Effects of Snow

In the experience of the author and other researchers (Politovich and Sand, 1981, p. 17) snow has never accreted in noticeable amounts on the airframe of the research aircraft in flight. Neither has snow registered on the Rosemount model 871FA ice detectors. But snow may still contribute to icing on components of helicopters or in engine inlets of helicopters and other light aircraft. There may also be some combinations of airspeed and ambient temperature at which snow may stick to airframes. Indeed, during the winter of 1981-82 alone, newspapers carried reports of at least two light aircraft that were forced to land in snowstorms. One was a twin engine Beechcraft on which one engine failed at 6000 ft in a snowstorm shortly after takeoff from Baltimore-Washington International airport on December 15, 1981; the plane made an emergency belly landing on a highway after the second engine began to fail. The other incident occurred on December 26, 1981 when a Beechcraft Baron crashed in a field near Hayden, Colorado, during a blizzard in that Rocky Mountain area. All three persons aboard the plane were killed.

On the other hand, it is a well-known fact that snow has the beneficial effect of drying up supercooled droplets in a cloud. This effect is due to the reduced pressure of water vapor near an ice surface compared to a water surface. The result is that the water droplets in the cloud will evaporate as water vapor is taken out of the air in the cloud by any snowflakes or ice particles that may be there. Appreciable quantities of snow or other ice particles in a supercooled cloud will rather quickly "dry up" the supercooled cloud droplets.

Research data confirms this phenomenon and shows that the LWC and number concentration of supercooled cloud droplets are very small in the presence of notable snowfall along the flight path. Indeed, during flight through a snowstorm one may see nothing but "cloud" in all directions, but normally the "cloud" will not be sufficiently dense for its passage over the wing of the aircraft to be noticeable. In a typical water droplet cloud, one can easily see the cloud at least partially obscuring the wing tips.

This tenuous nature of a widespread snowstorm "cloud" was observed most notably by the author who was a passenger aboard a Boeing 727 in the same snowstorm that was associated with the Air Florida crash in Washington, DC on January 13, 1982. On a flight from St. Louis to Baltimore that same afternoon, the 727 type aircraft entered the top of the widespread cloud system at about 35,000 ft at the start of the descent toward Baltimore. The plane was in continuous "cloud" throughout the entire descent though neither the snow nor the "cloud" was sufficiently dense to be noticeable over the length of the wing. Only when the ground became visible at 2000 ft or less on final approach could the moderately heavy and steady snowfall be recognized. The relatively dark and definite background of trees outside the perimeter of the approach path were needed to make the snowflakes visible. A widespread snowstorm of this type might aptly be described as largely snow and no cloud in the sense of a distinguishable droplet cloud.

b. Effects of Graupel or Rain

Graupel and rain have both been observed to actually assist in the removal of accreted rime ice from the leading surface of the wings (Jeck, 1980, p. 64), (Politovich and Sand, 1981, p. 17). The accreted rime usually breaks away in 1 to 3-inch wide pieces at random positions along the wing. The instances noted by the author all occurred at ambient air temperatures of not more than 2 or 3 degrees Celsius below freezing so that softening of the ice may have been expected anyway. In addition, the efficiency of this impact-assisted deicing is probably a function of flight speed and may therefore be less effective at the slower speeds of helicopters.

c. Variability of Cloud Conditions

Most of the research flights reflect considerable variability in cloud base height, cloud layer thickness, and the number of distinct layers as a function of position and time. In such circumstances, it can be appreciated, that the prediction of icing severity and extent at a given location or altitude would be difficult except perhaps for forecasting the worst icing conditions to be expected for a given period. (Jeck, 1980, p. 64)

REFERENCES

"Aerographer's Mate 1 & C," Naval Education and Training Support Command Manual No. NAVEDTRA 10362-B (1974), Government Printing Office, Washington, DC.

Borovikov, A.M., Khrgian, A.K., et al., Cloud Physics, Israel Program for Scientific Translations, Jerusalem, 1963.

Brun, R.J., Lewis, W., Perkins, P.J., and Serafini, J.S., "Impingement of Cloud Droplets on a Cylinder and Procedure for Measuring Liquid-Water Content and Droplet Sizes in Supercooled Clouds by Rotating Multicylinder Method," NACA Report No. 1215 (1955).

Feddes, R.G., "A Synoptic-Scale Model for Simulating Condensed Atmospheric Moisture," USAF/ETAC Report No. TN 74-4 (1974), USAF Environmental Technical Applications Center, Scott AFB, Illinois 62225.

Federal Aviation Regulations, Part 25 (FAR-25), "Airworthiness Standards: Transport Category Airplanes," Appendix C. Washington, DC 20591: U.S. Department of Transportation, Federal Aviation Administration, 1974.

"Forecasters' Guide on Aircraft Icing," Report No. AWS/TR-80/001 (1980), Air Weather Service (MAC), Scott AFB, Illinois 62225.

Fye, F.K., "The AFGWC Automated Cloud Analysis Model," AFGWC Technical Memorandum 78-002 (1978), HQ Air Force Global Weather Central, Offutt AFB, Nebraska 68113.

Jackson, G.C., "Icing Climatology for Northern Europe," Report No. AFWAL-TN-80-16-FSW (1980), Air Force Wright Aeronautical Laboratories, Wright-Patterson AFB, Ohio 45433.

Jack, R.K., "Icing Characteristics of Low Altitude, Supercooled Layer Clouds," DOT/FAA Report No. FAA-RD-80-24 (1980).

Jones, A.R., and Lewis, W., "Recommended Values of Meteorological Factors to be Considered in the Design of Aircraft Ice-Prevention Equipment," NACA Technical Note TN-1855 (1949).

Kieutern, W., and Wblfer, G., "Some Recent Results on Icing Parameters," Proc. of Sept. 1977 meeting of the NATO Advisory Group for Aerospace Research and Development, Ottawa, Canada; Report No. AGARD-AR-127.

Kline, D.B., and Walker, J.A., "Meteorological Analysis of Icing Conditions Encountered in Low-Altitude Stratiform Clouds," NACA Technical Note TN-2306 (1951).

Lewis, W., "A Flight Investigation of the Meteorological Conditions Conducive to the Formation of Ice on Airplanes," NACA Technical Note TN-1393 (1947).

Lewis, W., and Bergrun, N.R., "A Probability Analysis of the Meteorological Factors Conducive to Aircraft Icing in the United States," NACA Technical Note TN-2738 (1952).

Lewis, W., and Hoecker, W.H., Jr., "Observations of Icing Conditions Encountered in Flight During 1948," NACA Technical Note TN-1904 (1949).

Lewis, W., Kline, D.B., and Steinmetz, C.P., "A Further Investigation of the Meteorological Conditions Conducive to Aircraft Icing," NACA Technical Note TN-1424 (1947).

Lewis, W., "Review of Icing Criteria," in Aircraft Ice Protection, Report of Symposium of April 28-30, 1969. DOT/FAA Flight Standards Service, 1969.

Ludlam, F.H., "The Heat Economy of a Rimed Cylinder," Quart. J. Roy. Met. Soc. 77, 663 (1951).

Ludlam, F.H., Clouds and Storms: The Behavior and Effect of Water in the Atmosphere. (The Pennsylvania State University Press, University Park, Pennsylvania, 1980).

Politovich, M., and Sand, W., "Atmospheric Conditions Contributing to Aircraft Icing," DOT/FAA Report No. FAA-CT-82-71 (1982).

Smith, R.D., "Atmospheric Moisture Parameterization," USAF/ETAC Report No. TN 74-1 (1974), USAF Environmental Technical Applications Center, Scott AFB, Illinois 62225.

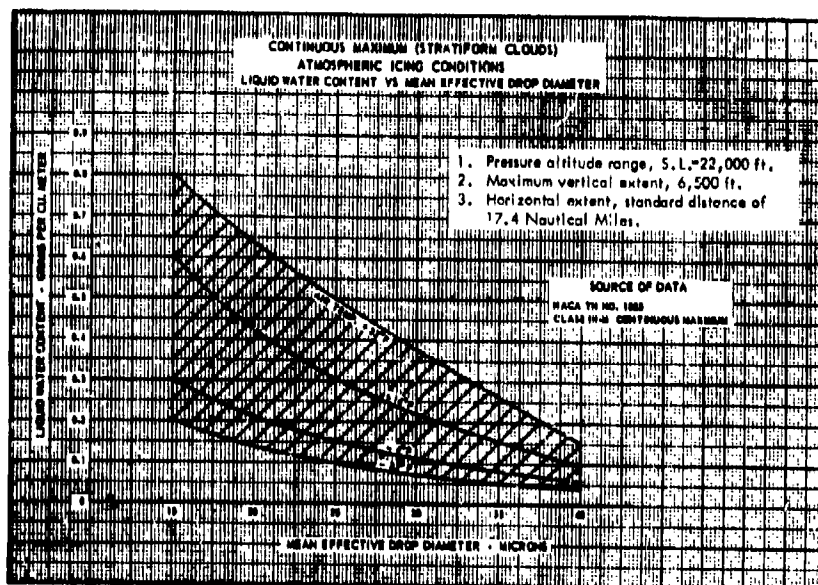


FIGURE 1. CONTINUOUS MAXIMUM ICING ENVELOPE. As promulgated in FAR-25, Appendix C, the maximum continuous intensity of atmospheric icing conditions is defined by the variables of LWC, MVD, and ambient air temperature, and the interrelationships of these variables as shown here.

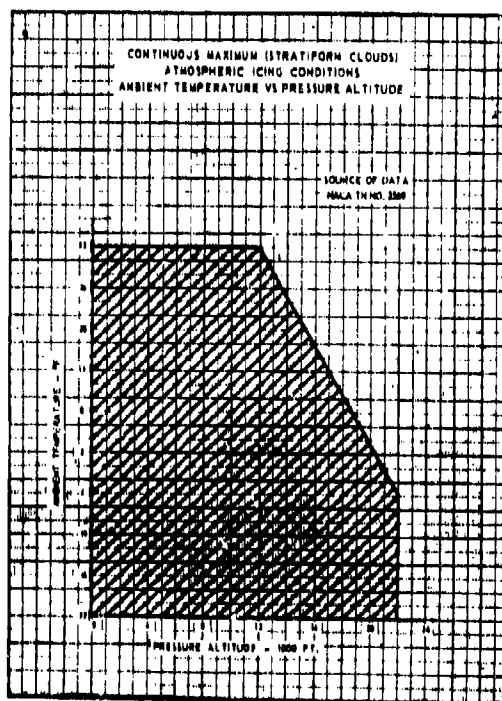


FIGURE 2. CONTINUOUS MAXIMUM ENVELOPE OF TEMPERATURE VS. ALTITUDE (FROM FAR-25, APP. C.)

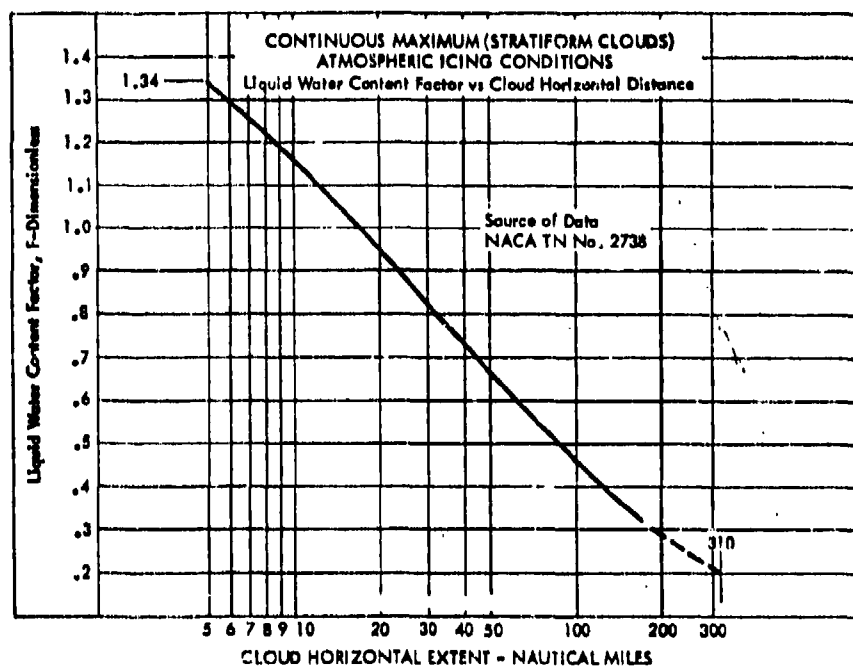


FIGURE 3. ADJUSTMENT FACTOR FOR LWC VS. CLOUD HORIZONTAL EXTENT FOR CONTINUOUS MAXIMUM ICING CONDITIONS (FROM FAR-25, APP. C)

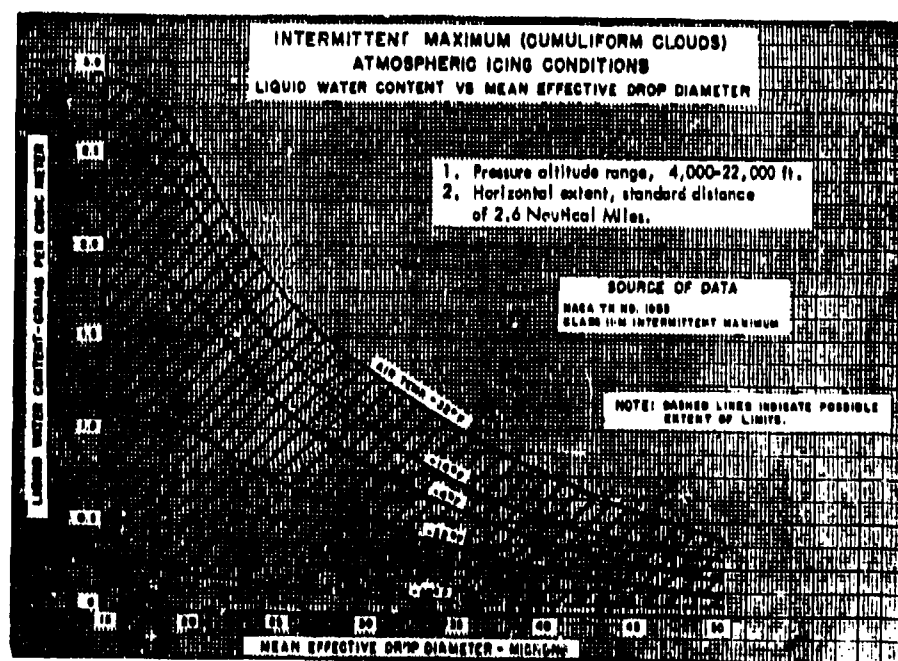


FIGURE 4. INTERMITTENT MAXIMUM ICING ENVELOPE. As promulgated in FAR-25, Appendix C, the intermittent maximum intensity of atmospheric icing conditions is defined by the variables of LWC, MVD, and ambient air temperature, and the interrelationships of these variables as shown here.

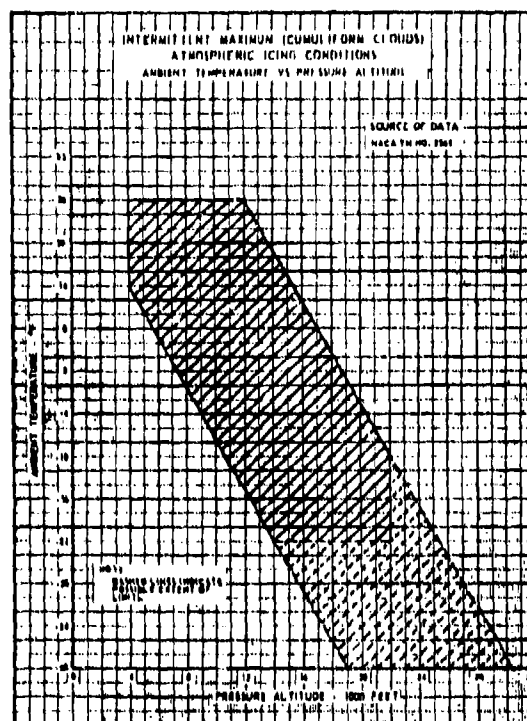


FIGURE 5. INTERMITTENT MAXIMUM ENVELOPE OF TEMPERATURE VS. ALTITUDE (FROM FAR-25, APP. C.)

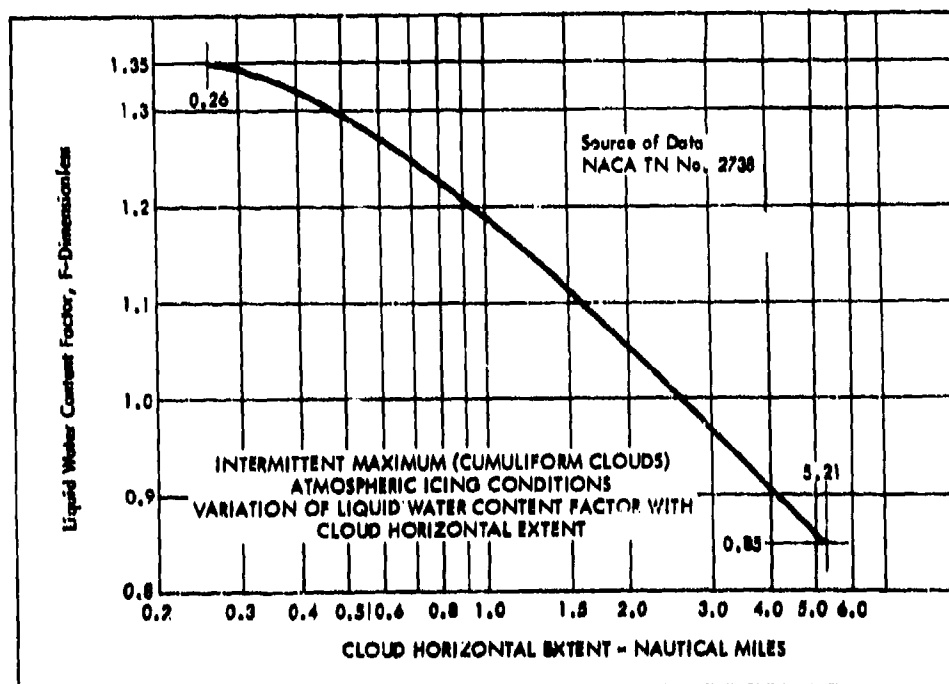


FIGURE 6. ADJUSTMENT FACTOR FOR LWC VS. CLOUD HORIZONTAL EXTENT FOR INTERMITTENT ICING CONDITIONS (FROM FAR-25, APP. C)

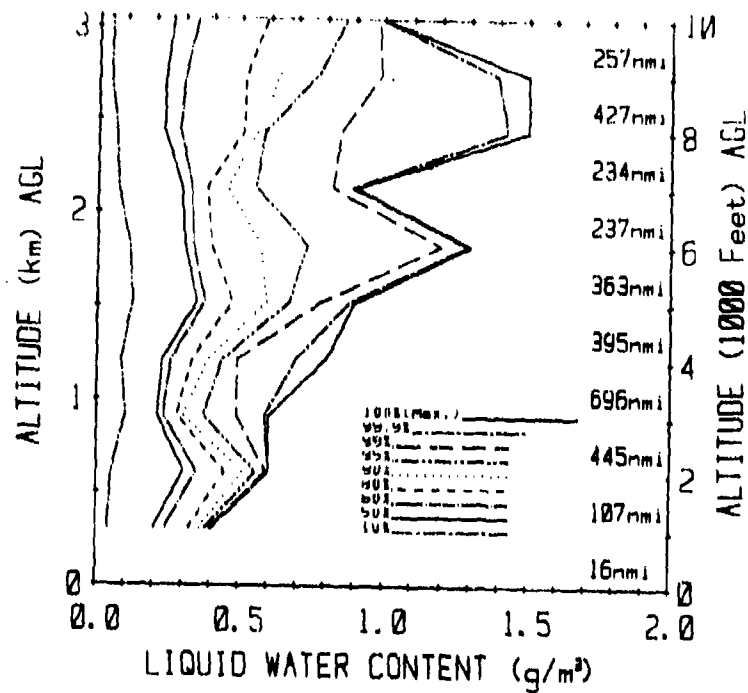


FIGURE 7. ALTITUDE VARIATION OF SUPERCOOLED LWC FOR ALL CLOUD TYPES AS OBSERVED IN THE NACA DATA (1946-1950). At each 1000 ft level the nth percentile curves indicate the value of LWC that was unexceeded in n% of the data miles recorded in supercooled clouds within the 1000 ft altitude interval immediately below. The right-hand column of numbers gives the number of data miles accumulated within each 1000 ft interval. A total of 3170 data miles is represented in this figure.

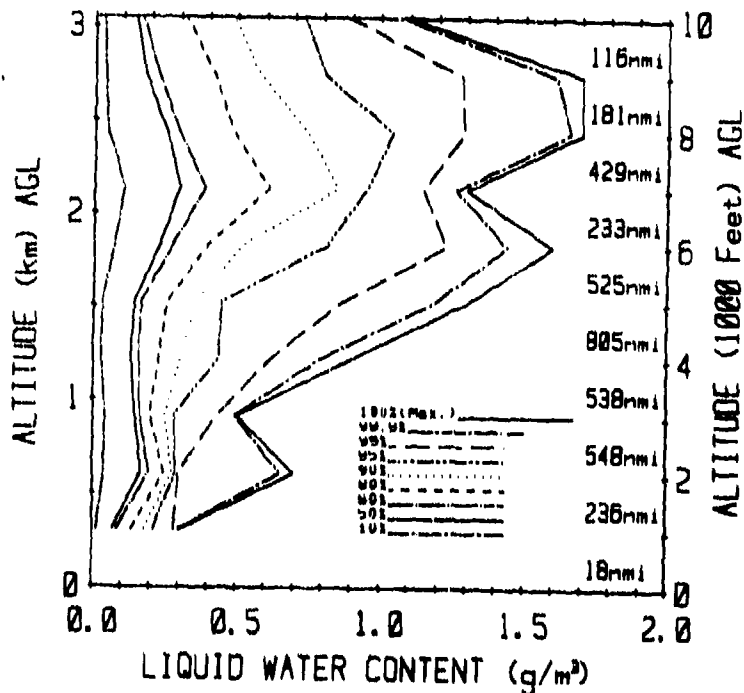


FIGURE 8. ALTITUDE VARIATION OF SUPERCOOLED LWC FOR ALL CLOUD TYPES AS OBSERVED IN THE MODERN DATA. At each 1000 ft level the nth percentile curves indicate the value of LWC that was unexceeded in n% of the data miles recorded in supercooled clouds within the 1000 ft altitude interval immediately below. The right-hand column of numbers gives the number of data miles accumulated within each 1000 ft interval. A total of 3630 data miles is represented in this figure.

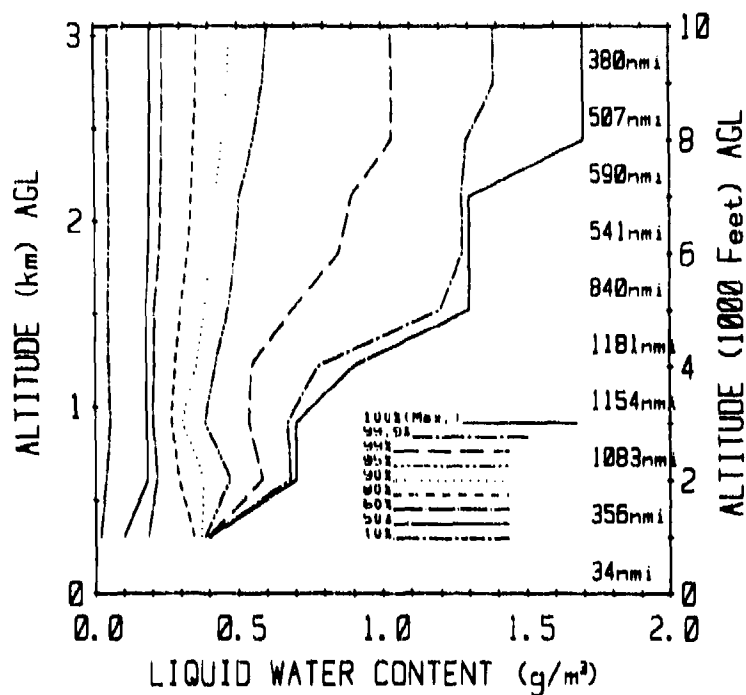


FIGURE 9. CUMULATIVE VARIATION WITH ALTITUDE FOR SUPERCOOLED LWC FROM ALL CLOUD TYPES AS RECORDED IN THE ENTIRE CONUS DATA BASE. At each 1000 ft level the pth percentile curves indicate the value of LWC that was unexceeded in p% of the data miles accumulated at all altitudes below the specified level. The right-hand column of numbers gives the number of data miles recorded within each 1000 ft interval. A total of 6660 data miles is represented in this Figure.

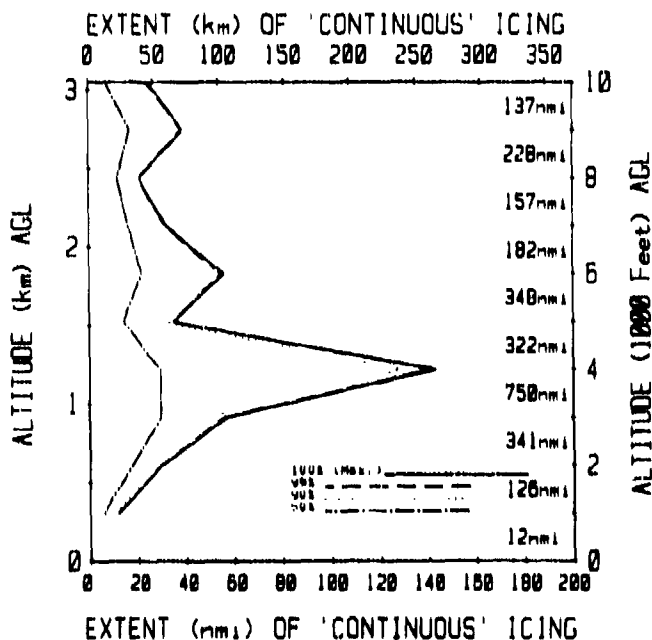


FIGURE 10. ALTITUDE VARIATION OF HORIZONTAL EXTENTS OF EXTENDED ICING ENCOUNTERS IN LAYER CLOUDS (Ns, As, Rs, As, Ac) AS OBSERVED IN THE NALA DATA (1946-1950). An extended encounter is a series of consecutive icing events added together sequentially until a gap of some specified duration (3 nmi for this case) is reached. At each 1000 ft level the pth percentile curves indicate the horizontal extent which was unexceeded in p% of the extended encounters within the 1000 ft altitude interval immediately below. The right-hand column of numbers gives the number of data miles contributing within each 1000 ft interval. A total of 2600 data miles is represented in this Figure.

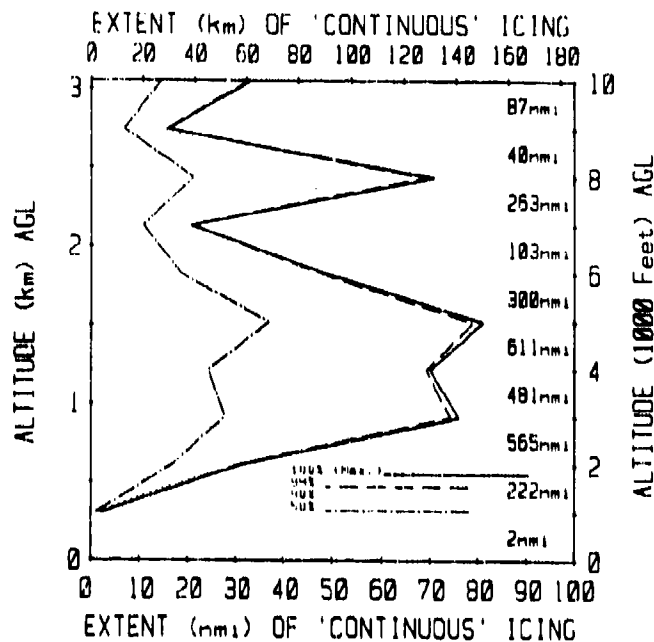


FIGURE 11. ALTITUDE VARIATION OF HORIZONTAL EXTENTS OF EXTENDED ICING ENCOUNTERS IN LAYER CLOUDS (Al, Sc, Ns, As, Ac) AS OBSERVED IN THE MODERN DATA. An extended encounter is a series of consecutive icing events added together sequentially until a gap of some specified duration (1 nmi for this case) is reached. At each 1000 ft level the 9th percentile curves indicate the horizontal extent which was unexceeded in 9% of the extended encounters within the 1000 ft altitude interval immediately below. The right-hand column of numbers give the number of data miles contributing within each 1000 ft interval. A total of 2675 data miles is represented in this Figure.

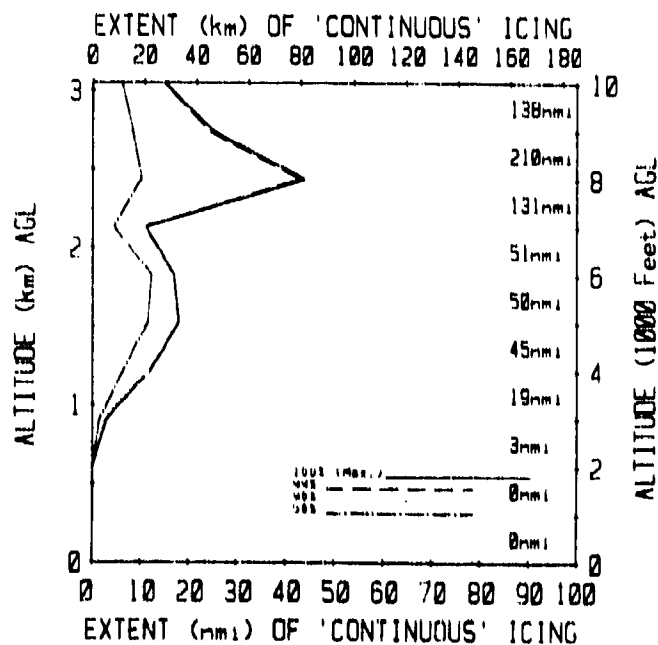


FIGURE 12. ALTITUDE VARIATION OF HORIZONTAL EXTENTS OF EXTENDED ICING ENCOUNTERS IN CONVECTIVE CLOUDS (Cu, cb) AS OBSERVED IN THE NACA DATA (1940-1950). An extended encounter is a series of consecutive icing events added together sequentially until a gap of some specified duration (1 nmi for this case) is reached. At each 1000 ft level the 9th percentile curves indicate the horizontal extent which was unexceeded in 9% of the extended encounters within the 1000 ft altitude interval immediately below. The right-hand column of numbers give the number of data miles contributing within each 1000 ft interval. A total of 650 data miles is represented in this Figure.

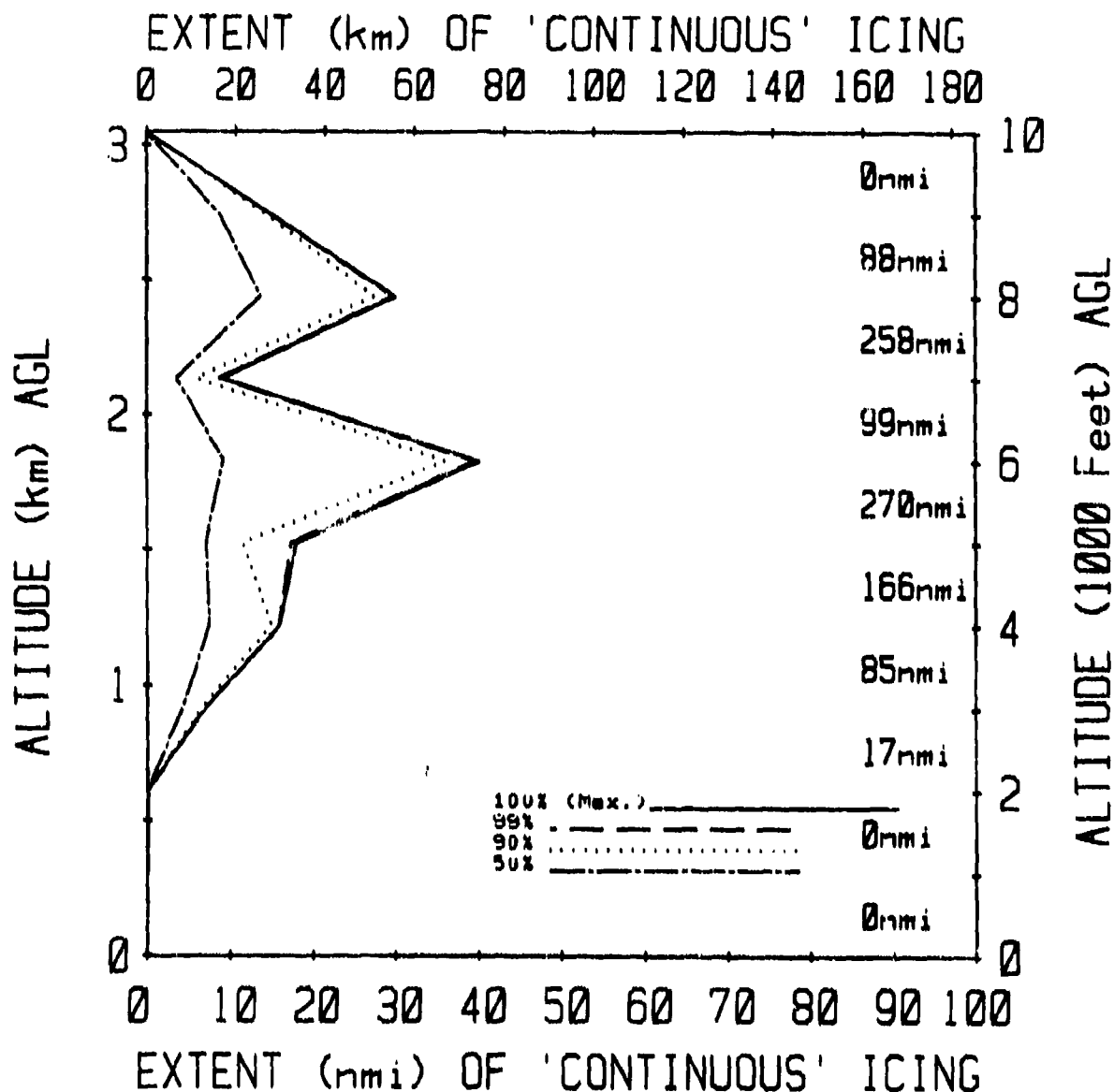


FIGURE 13. ALTITUDE VARIATION OF HORIZONTAL EXTENTS OF EXTENDED ICING ENCOUNTERS IN CONVECTIVE CLOUDS (Cu, Cb), AS OBSERVED IN THE MODERN DATA. An extended encounter is a series of consecutive icing events added together sequentially until a gap of some specified duration (3 nmi for this case) is reached. At each 1000 ft level the n th percentile curves indicate the horizontal extent which was unexceeded in $n\%$ of the extended encounters within the 1000 ft altitude interval immediately below. The right-hand column of numbers gives the number of data miles contributing within each 1000 ft interval. A total of 985 data miles is represented in this Figure.

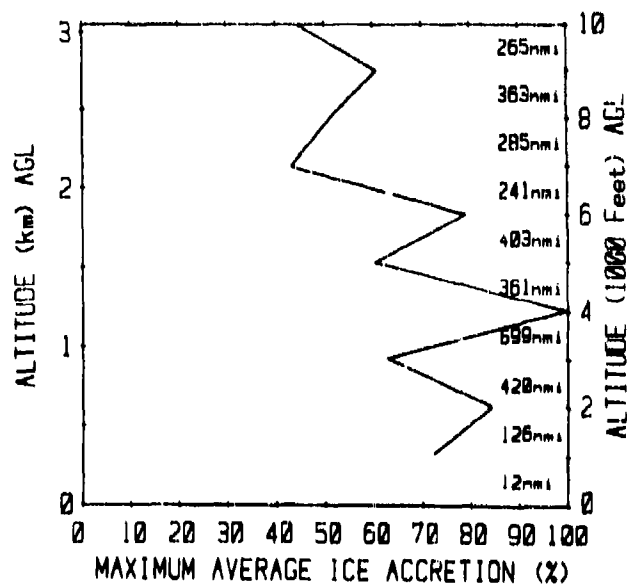


FIGURE 14. ALTITUDE VARIATION OF AVERAGE ICE ACCRETION PER EXTENDED ICING ENCOUNTER AS DETERMINED FROM THE NACA DATA (1946-1950). Ice accretion amounts represented by the product RH are computed for all extended icing encounters occurring in each 1000 ft altitude interval. The average value of RH for each altitude interval is expressed as a percentage of the largest of these interval-wide averages. At each 1000 ft level the plotted line indicates this percentage value for the 1000 ft altitude interval immediately below. An extended encounter is a series of consecutive icing events added together sequentially until a gap of some specified duration (3 mi for this case) is reached. R is the LWC averaged over the extended encounter (gaps not included) and H is the horizontal extent of the extended encounter (gaps not included). The right-hand column of numbers gives the number of data miles contributing within each 1000 ft interval. A total of 3170 data miles is represented in this Figure.

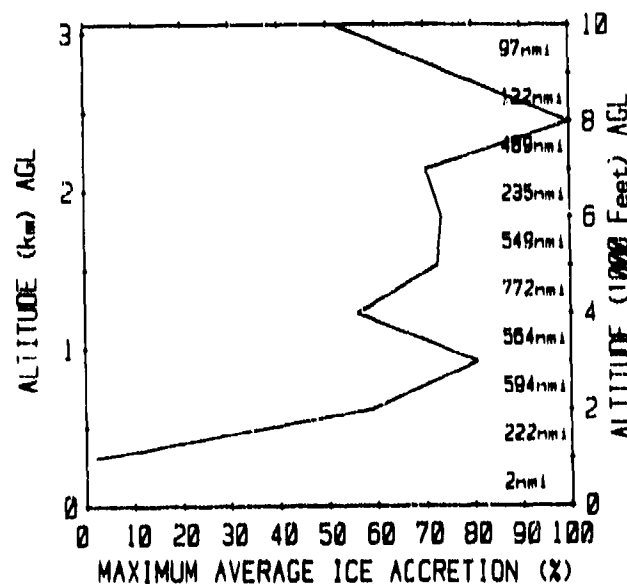


FIGURE 15. ALTITUDE VARIATION OF AVERAGE ICE ACCRETION PER EXTENDED ICING ENCOUNTER AS DETERMINED FROM THE MODERN DATA. Ice accretion amounts represented by the product RH are computed for all extended icing encounters occurring in each 1000 ft altitude interval. The average value of RH for each altitude interval is expressed as a percentage of the largest of these interval-wide averages. At each 1000 ft level the plotted line indicates this percentage value for the 1000 ft altitude interval immediately below. An extended encounter is a series of consecutive icing events added together sequentially until a gap of some specified duration (3 mi for this case) is reached. R is the LWC averaged over the extended encounter (gaps not included) and H is the horizontal extent of the extended encounter (gaps not included). The right-hand column of numbers gives the number of data miles contributing within each 1000 ft interval. A total of 3643 data miles is represented in this Figure.

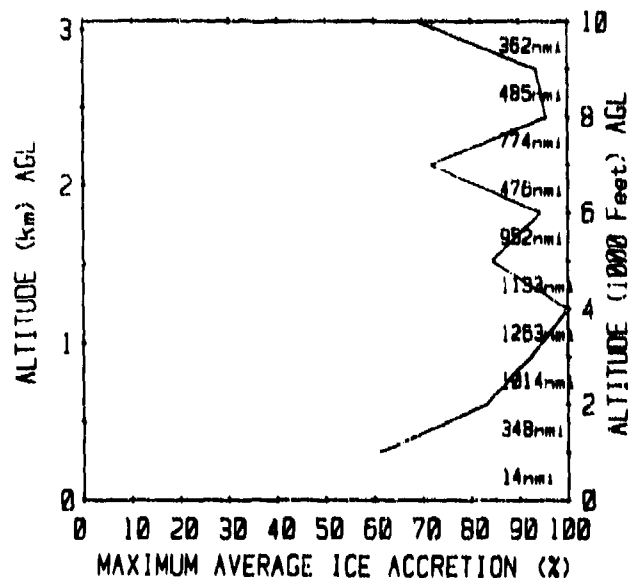


FIGURE 16. ALTITUDE VARIATION OF AVERAGE ICE ACCRETION PER EXTENDED ICING ENCOUNTER AS DETERMINED FROM THE COMBINED NACA AND MOOREN DATA. Ice accretion amounts represented by the product \bar{H} are computed for all extended icing encounters occurring in each 1000 ft altitude interval. The average value of \bar{H} for each altitude interval is expressed as a percentage of the largest of these interval-wide averages. At each 1000 ft level the plotted line indicates this percentage value for the 1000 ft altitude interval immediately below. An extended encounter is a series of consecutive icing events added together sequentially until a gap of some specified duration (3 min for this case) is reached. \bar{V} is the LWC averaged over the extended encounter (gaps not included) and \bar{H} is the horizontal extent of the extended encounter (gaps not included). The right-hand column of numbers gives the number of data miles contributing within each 1000 ft interval. A total of 6820 data miles is represented in this Figure.

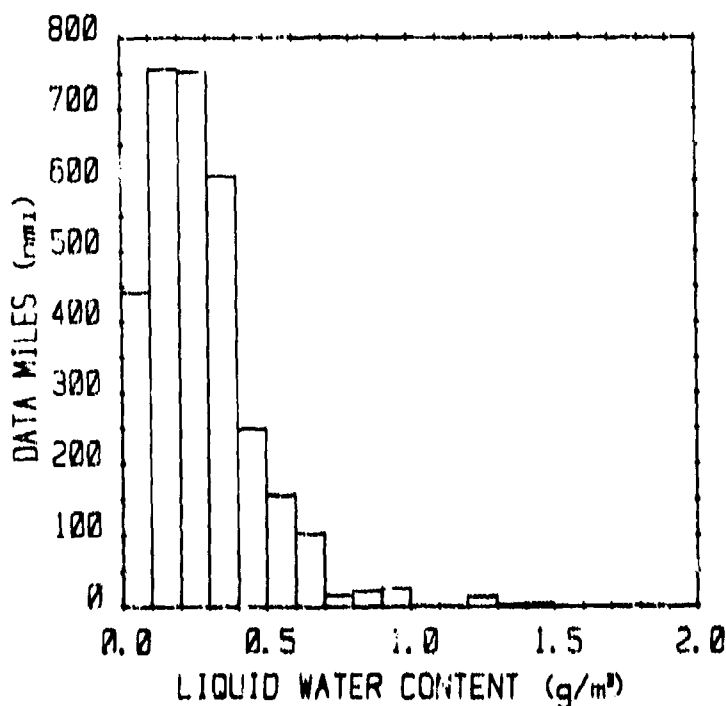


FIGURE 17. FREQUENCY DISTRIBUTION OF LWC IN ALL SUPERCOOLED CLOUD TYPES BELOW 10,000 FT AGL AS OBSERVED IN THE NACA DATA (1946-1950). A total of 12001 data miles is represented in this Figure.

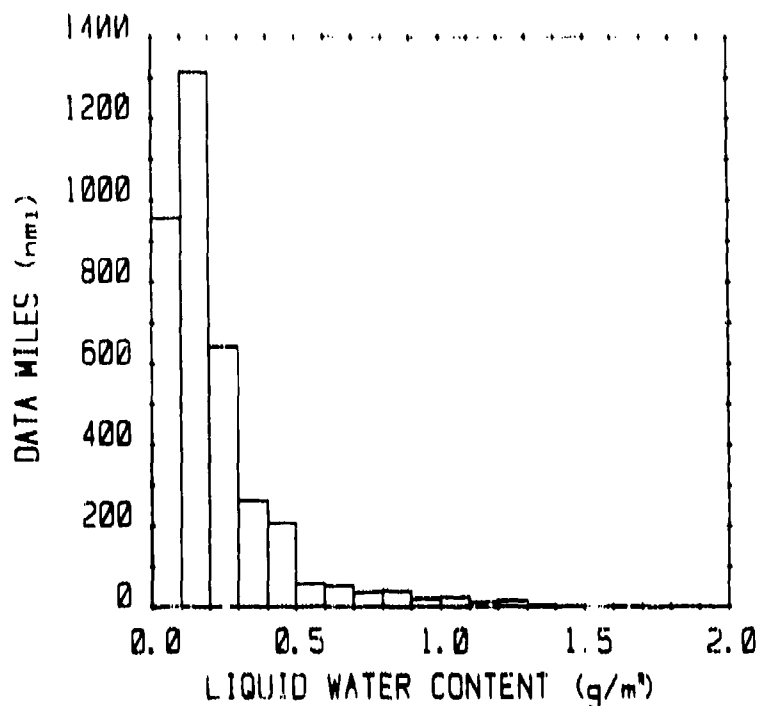


FIGURE 18. FREQUENCY DISTRIBUTION OF LWC IN ALL SUPERCOOLED CLOUD TYPES BELOW 10,000 FT AGL AS OBSERVED IN THE MODERN DATA. A total of 3643 data miles is represented in this figure.

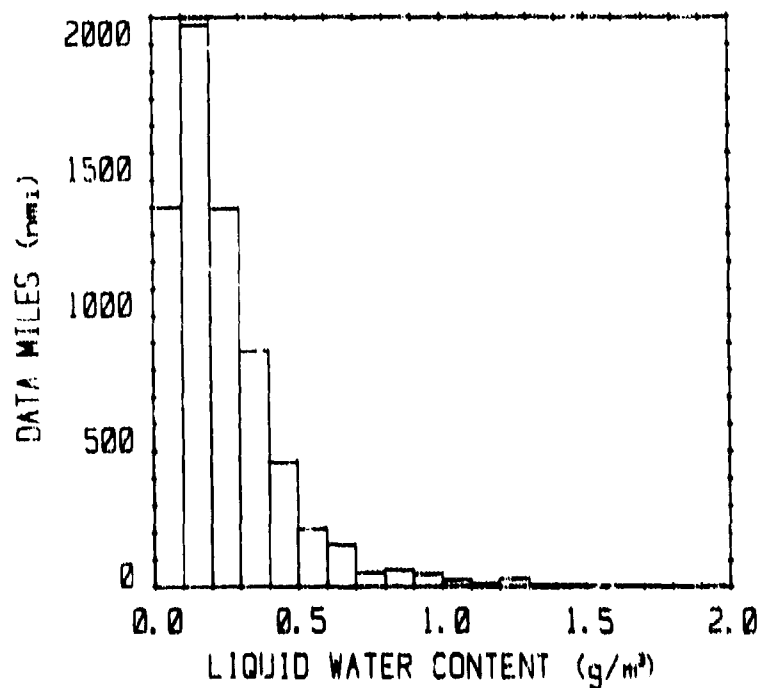


FIGURE 19. FREQUENCY DISTRIBUTION OF LWC IN ALL SUPERCOOLED CLOUD TYPES BELOW 10,000 FT AGL AS OBSERVED IN THE COMBINED NACA AND MODERN DATA. A total of 6850 data miles is represented in this figure.

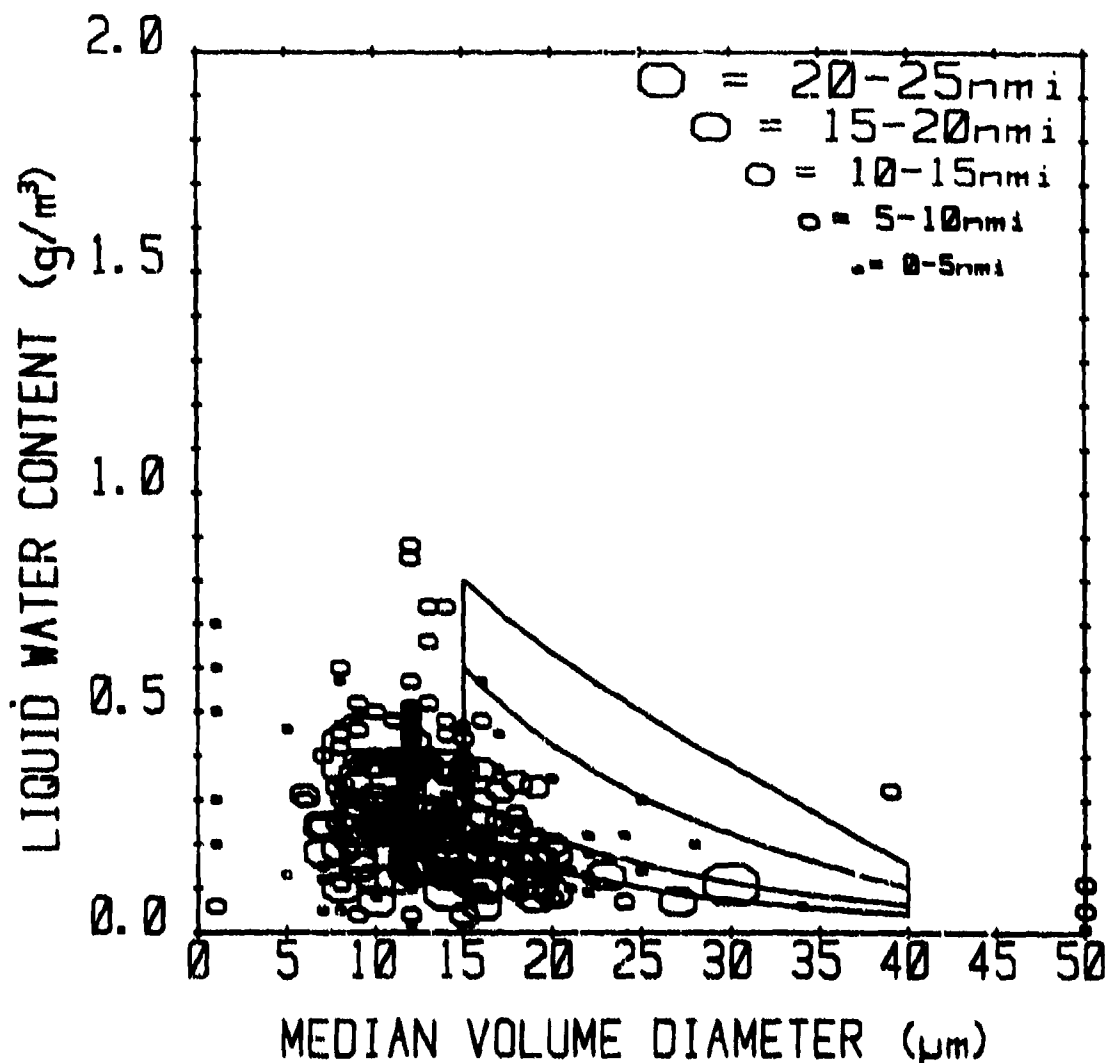


FIGURE 20. SCATTERPLOT OF OBSERVED LWC, MVD COMBINATIONS IN THE NACA DATA FOR LAYER CLOUDS UP TO 10,000 FT AGL AND FOR CLOUD TEMPERATURES FROM -10°C TO 0°C . The size of each plotted symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each plotted symbol corresponds to the average (and approximately constant) value of LWC and MVD observed during the icing event. Values of LWC for which no MVD measurements are available are plotted arbitrarily at $1\text{ }\mu\text{m}$ MVD. A total of 2105 data miles is represented in this graph. The Continuous Maximum envelope from FIG. 1 of FAR-25, App. C, is superimposed for comparison.

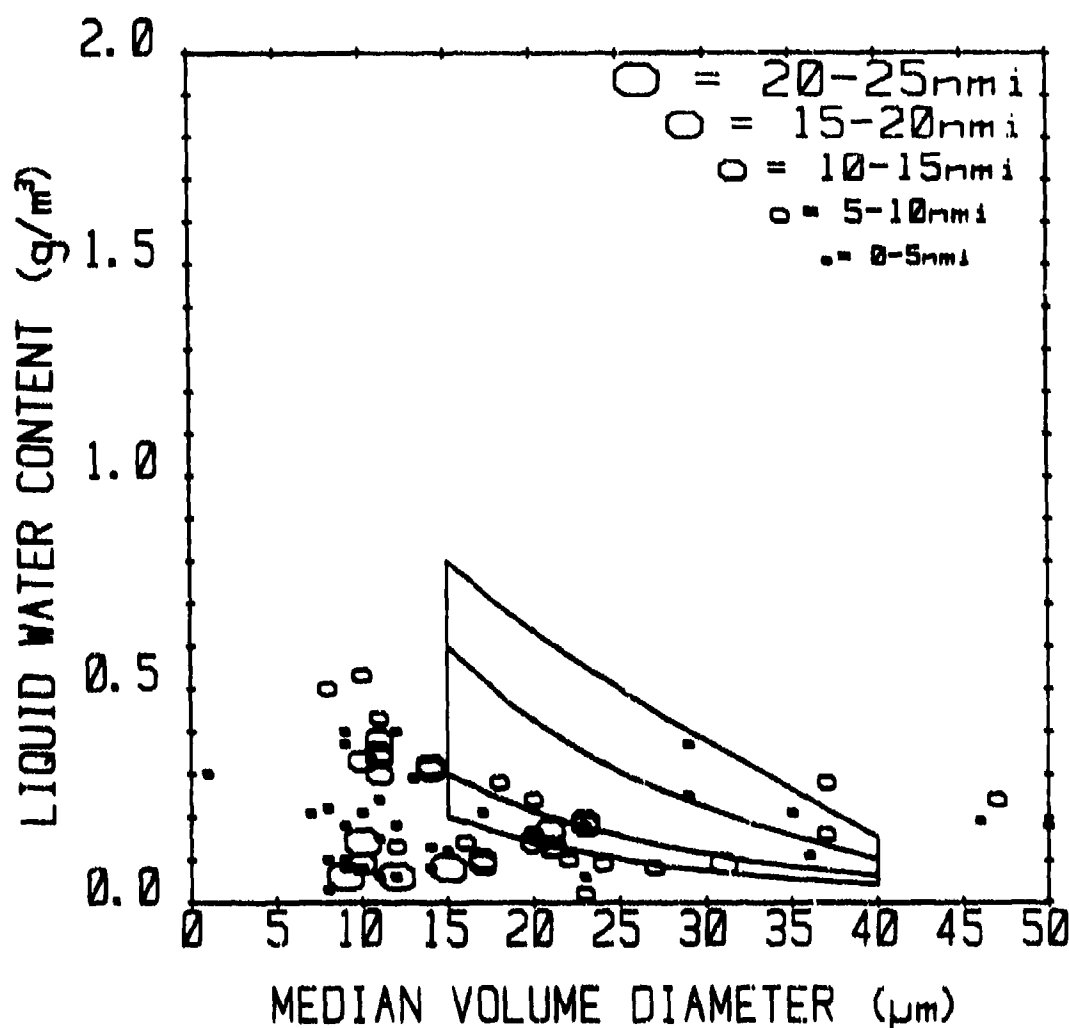


FIGURE 21. SCATTERPLOT OF OBSERVED LWC, MVD COMBINATIONS IN THE NACA DATA FOR LAYER CLOUDS UP TO 10,000 FT AGL AND FOR CLOUD TEMPERATURES FROM -20°C. to -10°C. The size of each plotted symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each plotted symbol corresponds to the average (and approximately constant) value of LWC and MVD observed during the icing event. Values of LWC for which no MVD measurements are available are plotted arbitrarily at $1\text{ }\mu\text{m}$ MVD. A total of 464 data miles is represented in this graph. The Continuous Maximum envelope from FIG. 1 of FAR-25, App. C, is superimposed for comparison.

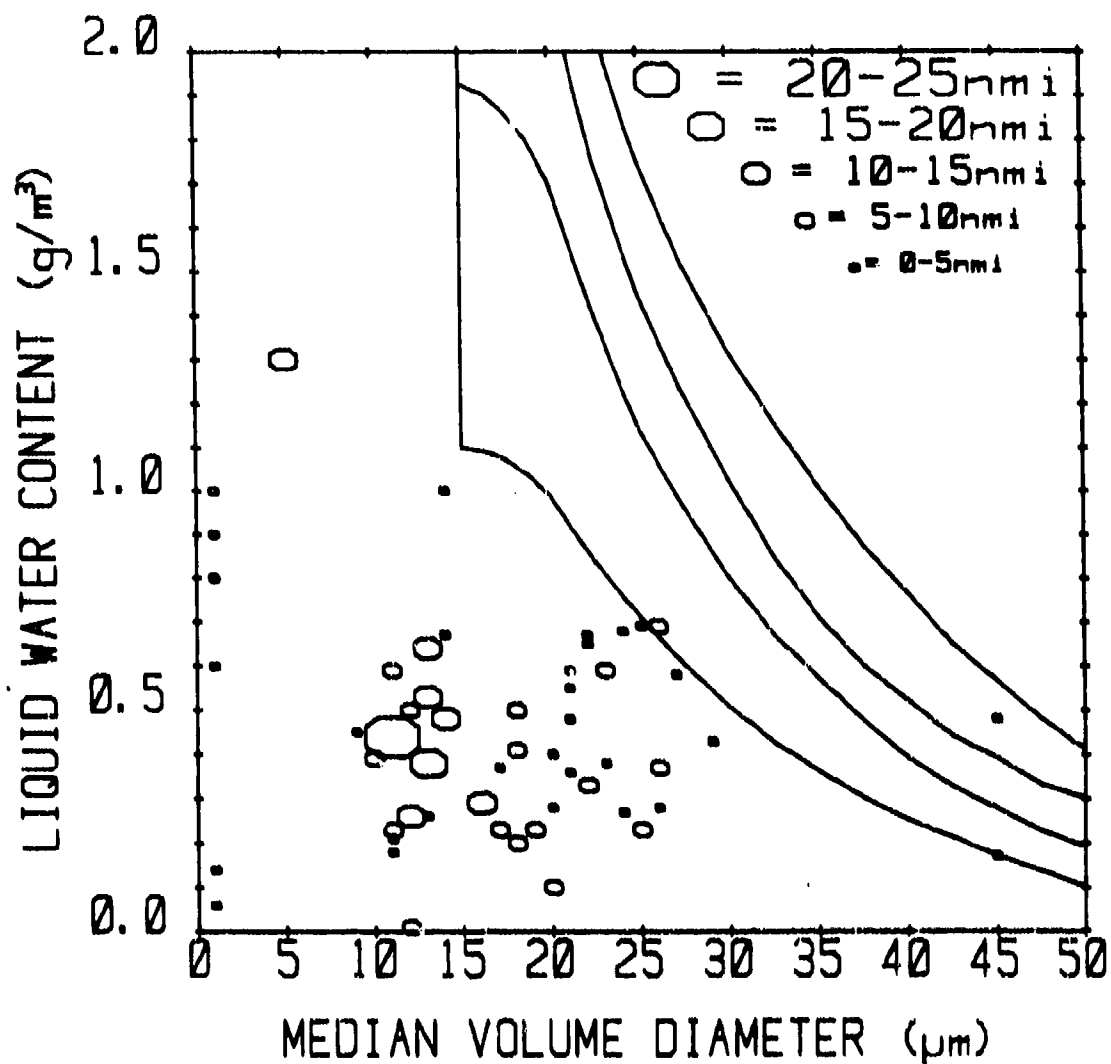


FIGURE 22. SCATTERPLOT OF OBSERVED LWC, MVD COMBINATIONS IN THE NACA DATA FOR CONVECTIVE CLOUDS UP TO 10,000 FT AGL AND FOR CLOUD TEMPERATURES FROM -10°C. to 0°C. The size of each plotted symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each plotted symbol corresponds to the average (and approximately constant) value of LWC and MVD observed during the icing event. Values of LWC for which no MVD measurements are available are plotted arbitrarily at $1\text{ }\mu\text{m}$ MVD. A total of 320 data miles is represented in this graph. The Intermittent Maximum envelope from FIG. 4 of FAR-25, App. C, is superimposed for comparison.

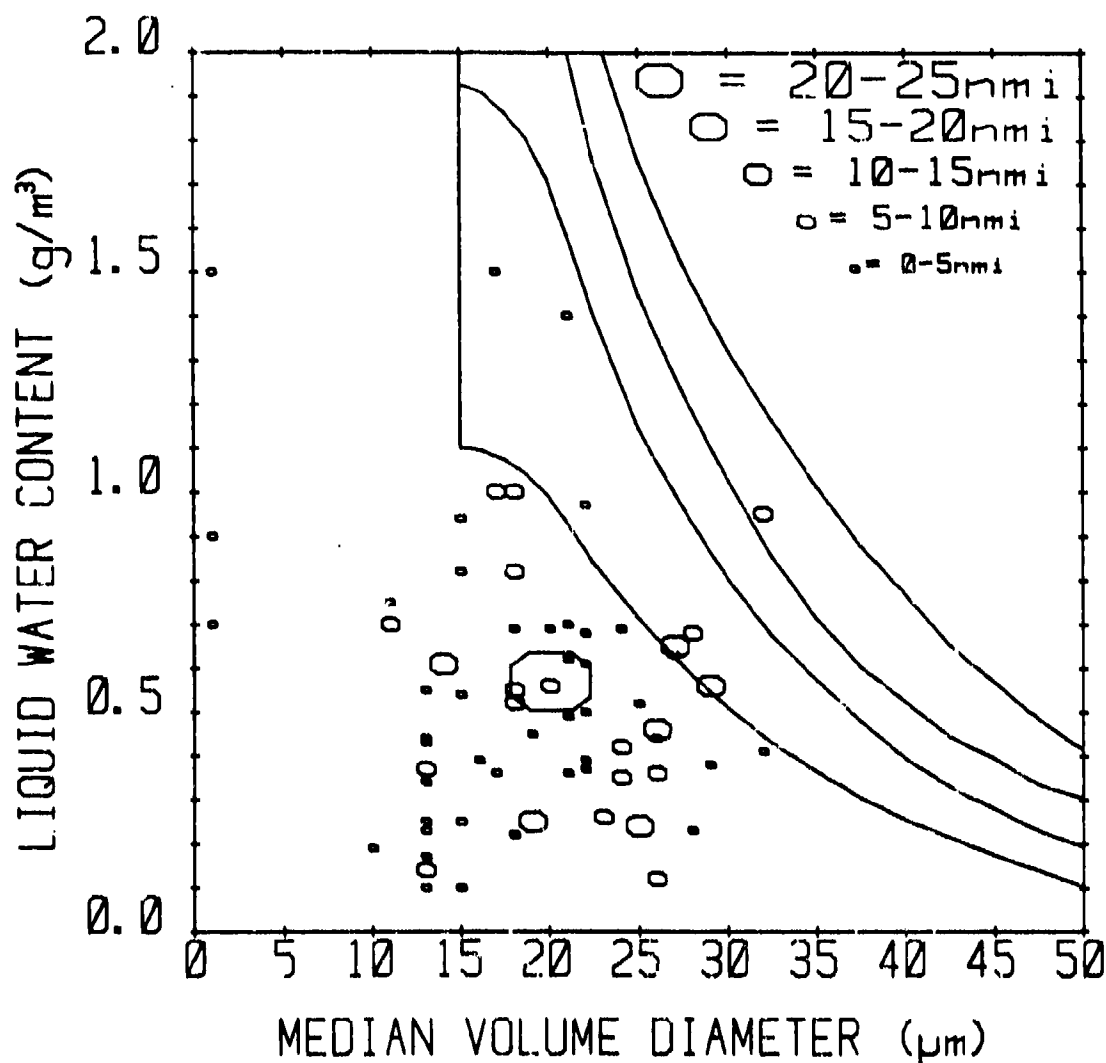


FIGURE 23. SCATTERPLOT OF OBSERVED LWC, MVD COMBINATIONS IN THE NACA DATA FOR CONVECTIVE CLOUDS UP TO 10,000 FT AGL AND FOR CLOUD TEMPERATURES FROM -20°C to -10°C . The size of each plotted symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each plotted symbol corresponds to the average (and approximately constant) value of LWC and MVD observed during the icing event. Values of LWC for which no MVD measurements are available are plotted arbitrarily at $1\text{ }\mu\text{m}$ MVD. A total of 315 data miles is represented in this graph. The Intermittent Maximum envelope from FIG. 4 of FAR-25, App. C, is superimposed for comparison.

$mynwac = 20-25nmi$
 $mynwac = 15-20nmi$
 $mynwac = 10-15nmi$
 $mynwac = 5-10nmi$

$mynwac = 0-5nmi$

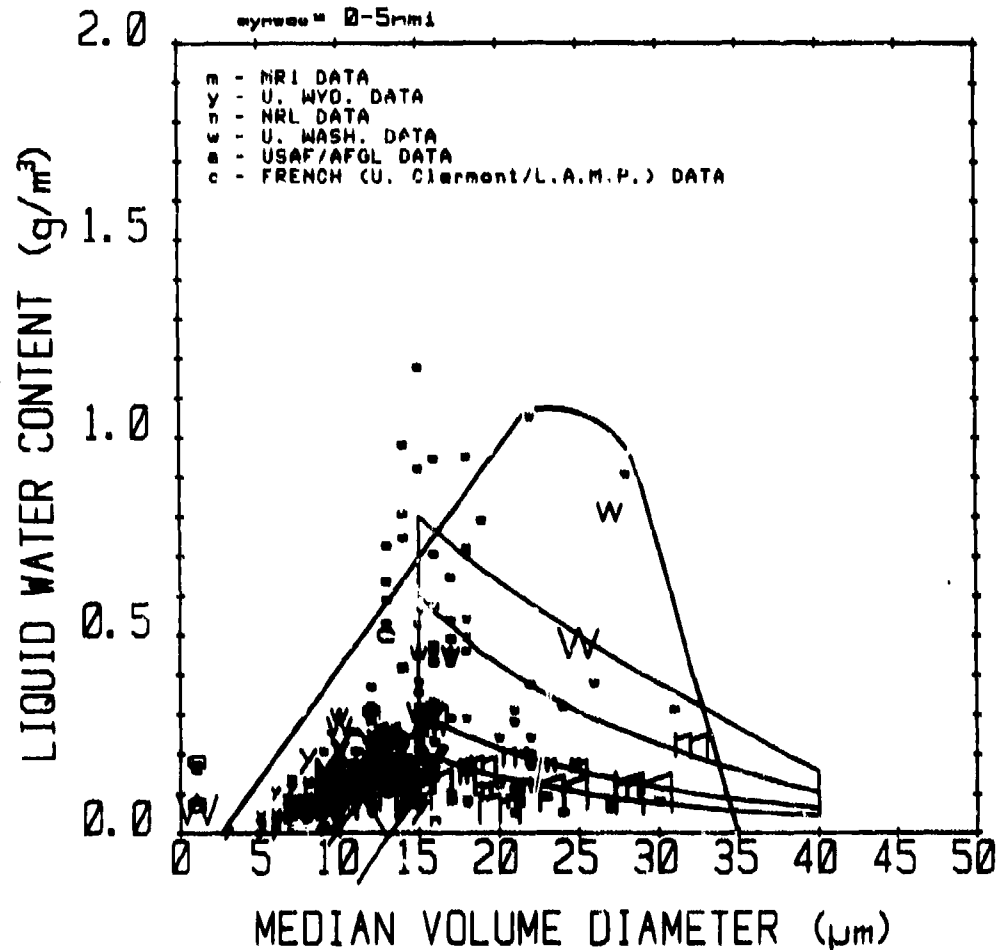


FIGURE 24. SCATTERPLOT OF OBSERVED LWC, MVD COMBINATIONS IN THE MODERN DATA FOR LAYER CLOUDS UP TO 10,000 FT AGL AND FOR CLOUD TEMPERATURES FROM -10°C TO 0°C . The various plotting symbols represent different data sources as indicated in the key. The size of each plotted symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each plotted symbol corresponds to the average (and approximately constant) value of LWC and MVD observed during the icing event. Values of LWC for which no MVD measurements are available are plotted arbitrarily at $1\text{ }\mu\text{m}$ MVD. A total of 1320 data miles is represented in this graph. The Continuous Maximum envelope from FIG. 1 of FAR-25, App. C, is superimposed for comparison. The other smooth curve is the observed, apparent limit to the CONUS data for this temperature interval.

$mynwac = 20-25nmi$
 $mynwac = 15-20nmi$
 $mynwac = 10-15nmi$
 $mynwac = 5-10nmi$
 $mynwac = 0-5nmi$

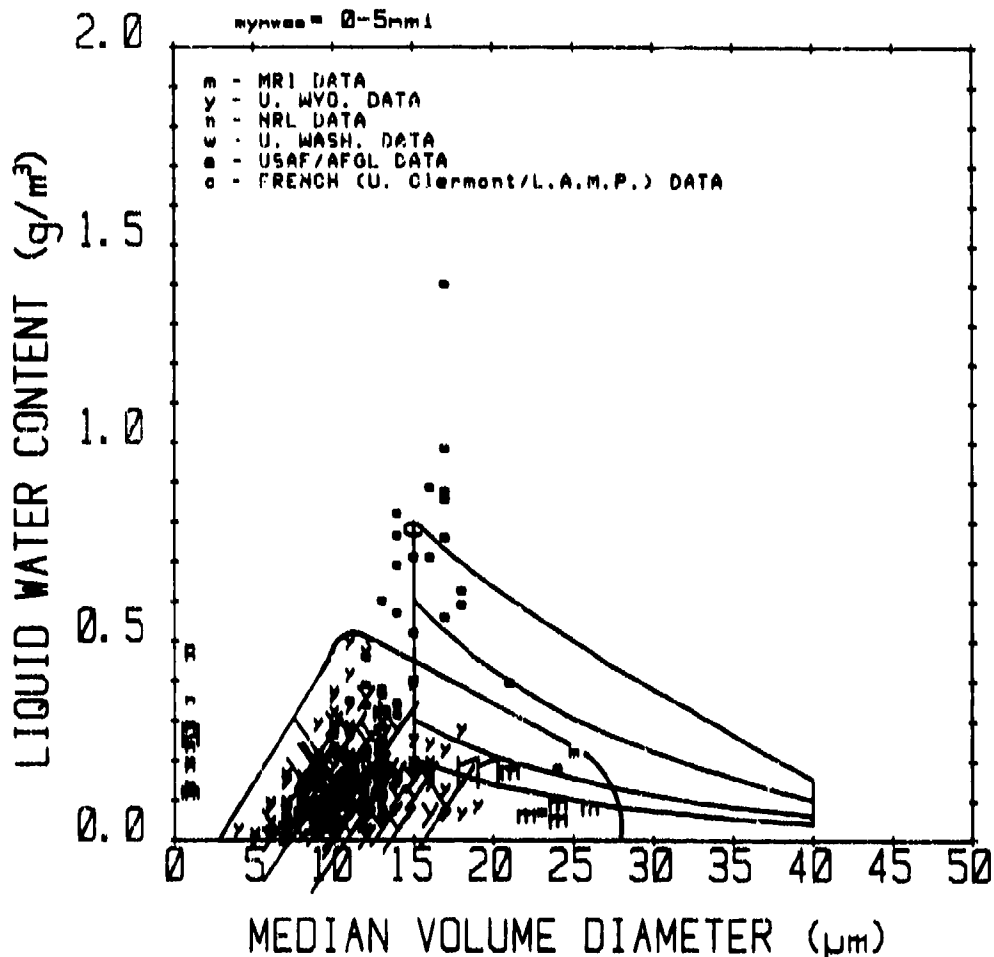


FIGURE 25. SCATTERPLOT OF OBSERVED LWC, MVD COMBINATIONS IN THE MODERN DATA FOR LAYER CLOUDS UP TO 10,000 FT AGL AND FOR CLOUD TEMPERATURES FROM -20°C to -10°C . The various plotting symbols represent different data sources as indicated in the key. The size of each plotted symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each plotted symbol corresponds to the average (and approximately constant) value of LWC and MVD observed during the icing event. Values of LWC for which no MVD measurements are available are plotted arbitrarily at $1\text{ }\mu\text{m}$ MVD. A total of 1180 data miles is represented in this graph. The Continuous Maximum envelope from FIG. 1 of FAR-25, App. C, is superimposed for comparison. The other smooth curve is the observed, apparent limit to the CONUS data for this temperature interval.

~~mynwac~~ = 20-25nmi
~~mynwac~~ = 15-20nmi
~~mynwac~~ = 10-15nmi
~~mynwac~~ = 5-10nmi
~~mynwac~~ = 0-5nmi

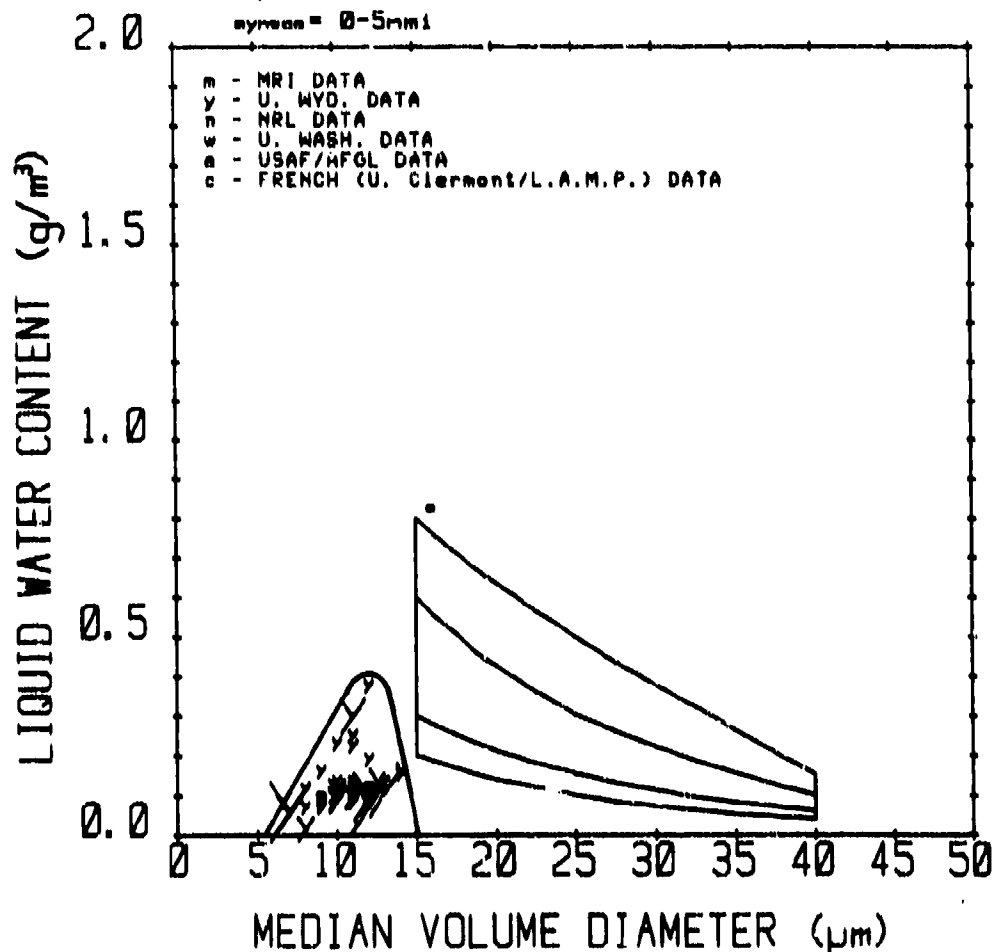


FIGURE 26. SCATTERPLOT OF OBSERVED LWC, MVD COMBINATIONS IN THE MODERN DATA FOR LAYER CLOUDS UP TO 10,000 FT AGL AND FOR CLOUD TEMPERATURES FROM -30°C to -20°C . The various plotting symbols represent different data sources as indicated in the key. The size of each plotted symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each plotted symbol corresponds to the average (and approximately constant) value of LWC and MVD observed during the icing event. Values of LWC for which no MVD measurements are available are plotted arbitrarily at $1\text{ }\mu\text{m}$ MVD. A total of 174 data miles is represented in this graph. The Continuous Maximum envelope from FIG. 1 of FAR-25, App. C, is superimposed for comparison. The other smooth curve is the observed, apparent limit to the CONUS data for this temperature interval.

~~m~~y~~n~~wac = 20-25nmi
~~m~~y~~n~~wac = 15-20nmi
~~m~~y~~n~~wac = 10-15nmi
~~m~~y~~n~~wac = 5-10nmi

mynwac = 0-5nmi

m - MRI DATA
 y - U. WYO. DATA
 n - NRL DATA
 w - U. WASH. DATA
 a - USAF/AFGL DATA
 c - FRENCH (U. Clermont/L.A.M.P.) DATA

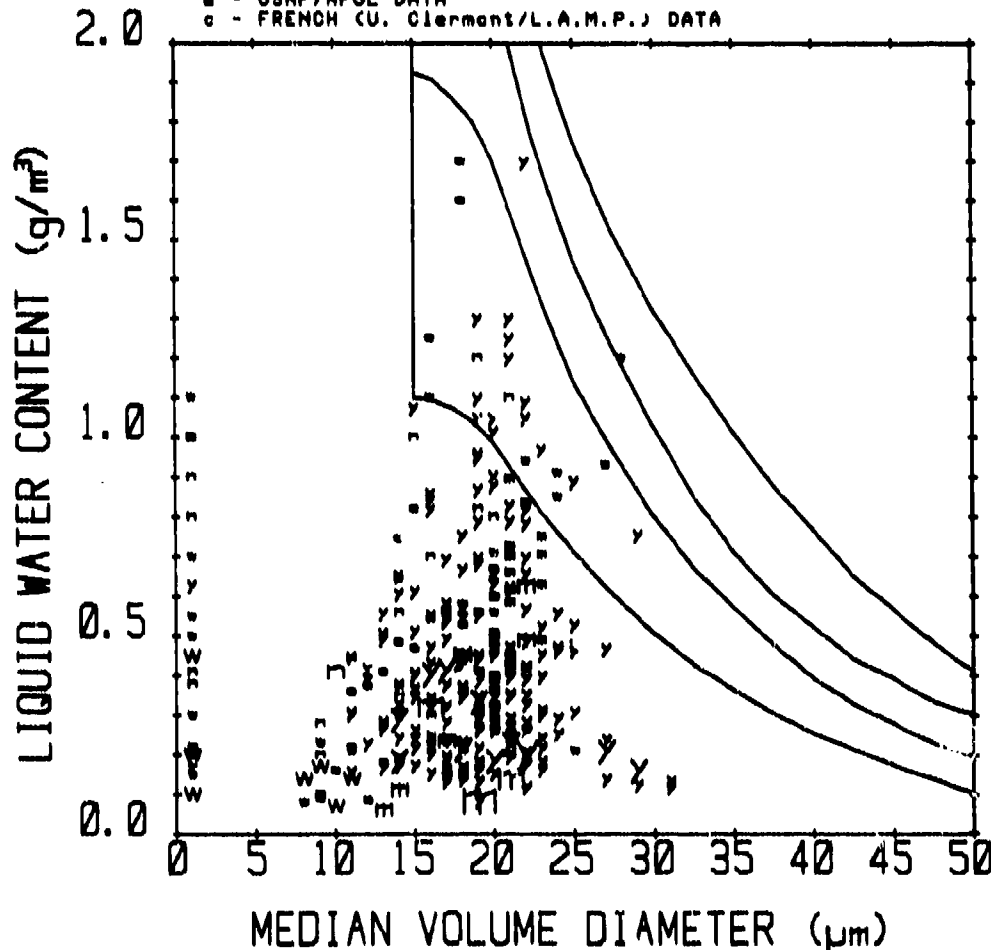


FIGURE 27. SCATTERPLOT OF OBSERVED LWC, MVD COMBINATIONS IN THE MODERN DATA FOR CONVECTIVE CLOUDS UP TO 10,000 FT AGL AND FOR CLOUD TEMPERATURES FROM -10°C TO 0°C . The various plotting symbols represent different data sources as indicated by the key. The size of each plotted symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each plotted symbol corresponds to the average (and approximately constant) value of LWC and MVD observed during the icing event. Values of LWC for which no MVD measurements are available are plotted arbitrarily at $1\text{ }\mu\text{m}$ MVD. A total of 734 data miles is represented in this graph. The Intermittent Maximum envelope from FIG. 4 of FAR-25, App. C, is superimposed for comparison.

$mynwac = 20-25nmi$
 $mynwac = 15-20nmi$
 $mynwac = 10-15nmi$
 $mynwac = 5-10nmi$
 $mynwac = 0-5nmi$

m - MRI DATA
 y - U. WYO. DATA
 n - HRL DATA
 w - U. WASH. DATA
 a - USAF/AFOL DATA
 o - FRENCH (U. Clermont/L.A.M.P.) DATA

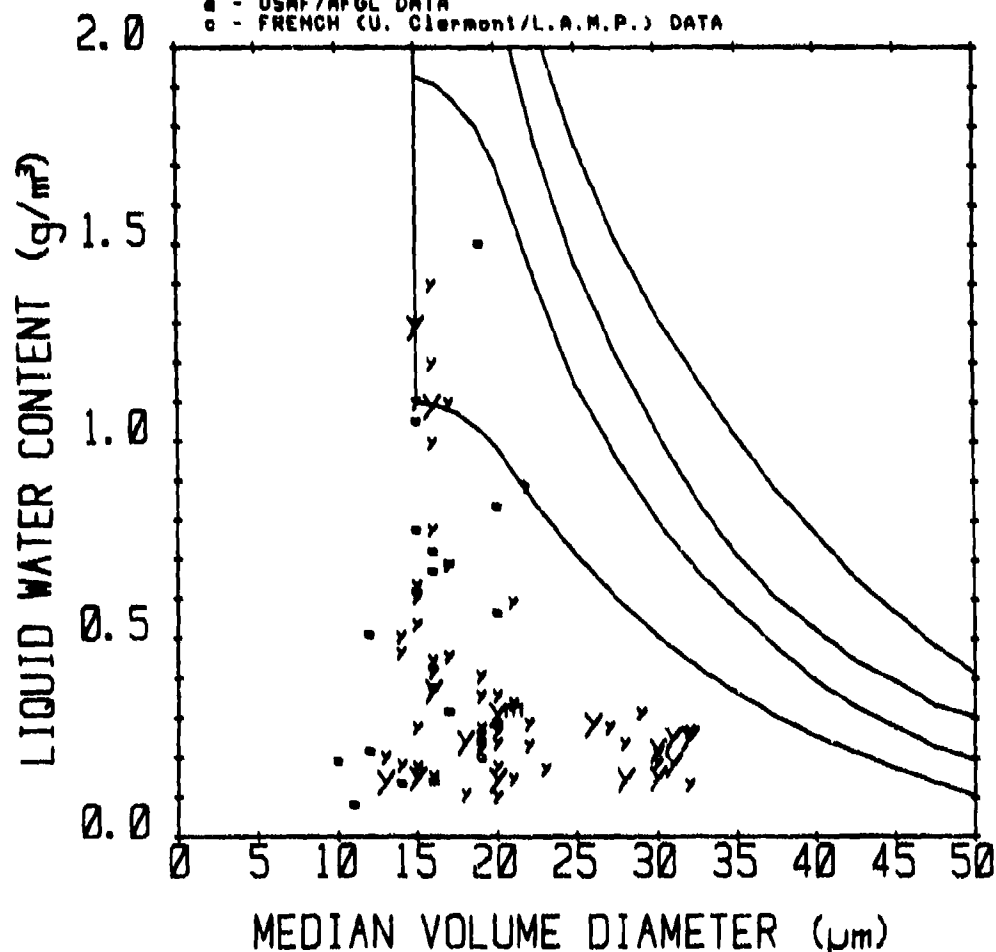


FIGURE 28. SCATTERPLOT OF OBSERVED LWC, MVD COMBINATIONS IN THE MODERN DATA FOR CONVECTIVE CLOUDS UP TO 10,000 FT AGL AND FOR CLOUD TEMPERATURES FROM -20°C to -10°C . The various plotting symbols represent different data sources as indicated by the key. The size of each plotted symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each plotted symbol corresponds to the average (and approximately constant) value of LWC and MVD observed during the icing event. Values of LWC for which no MVD measurements are available are plotted arbitrarily at $1\text{ }\mu\text{m}$ MVD. A total of 244 data miles is represented in this graph. The Intermittent Maximum envelope from FIG. 4 of FAR-23, App. C, is superimposed for comparison.

~~mynwac~~ = 20-25nmi
~~mynwac~~ = 15-20nmi
~~mynwac~~ = 10-15nmi
~~mynwac~~ = 5-10nmi
~~mynwac~~ = 0-5nmi

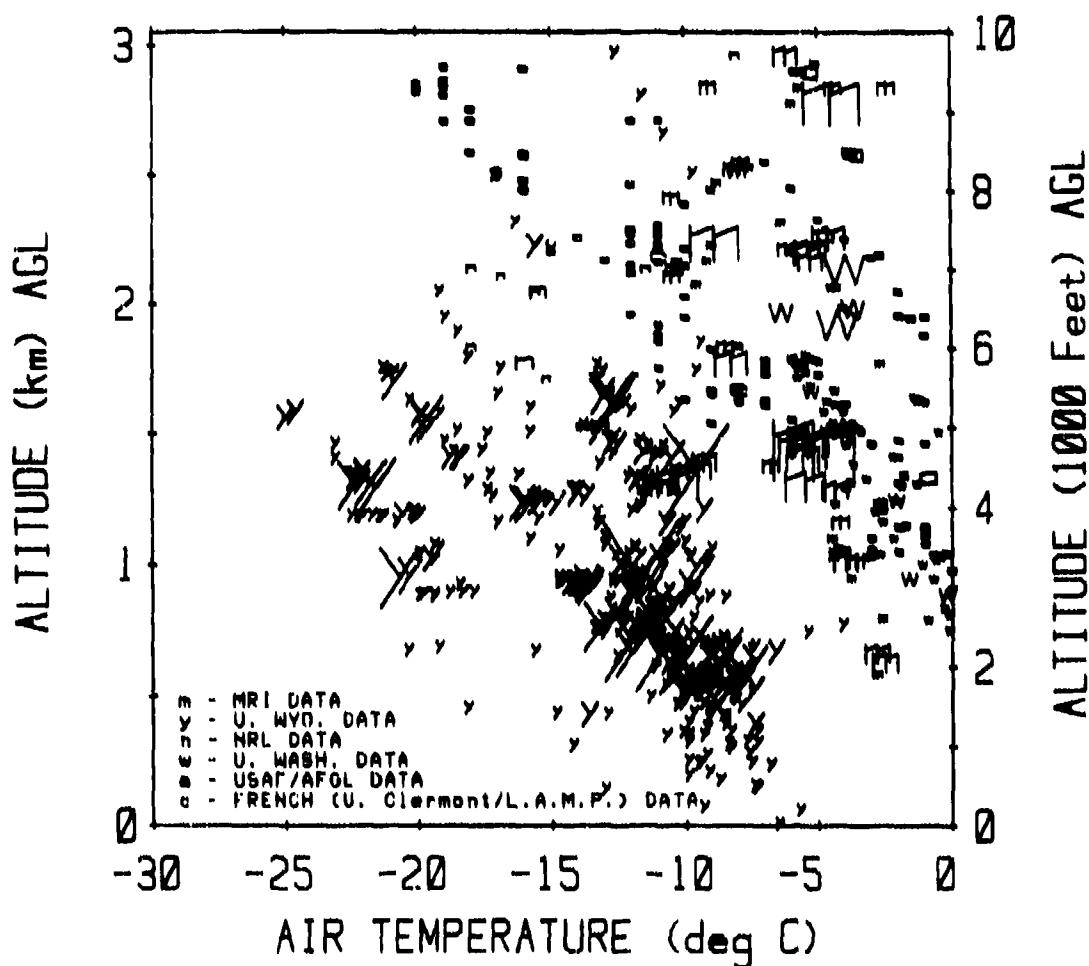


FIGURE 29. SCATTERPLOT OF ICING EVENT TEMPERATURES VS. ALTITUDE FOR MODERN DATA FROM SUPERCOOLED LAYER CLOUDS (St, Sc, Ns, As, Ac) UP TO 10,000 FT AGL. The various plotting symbols represent different data sources as indicated in the key. The size of each symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each symbol corresponds to the average (and approximately constant) value of altitude and OAT observed during the icing event. A total of 2660 data miles is represented in this graph.

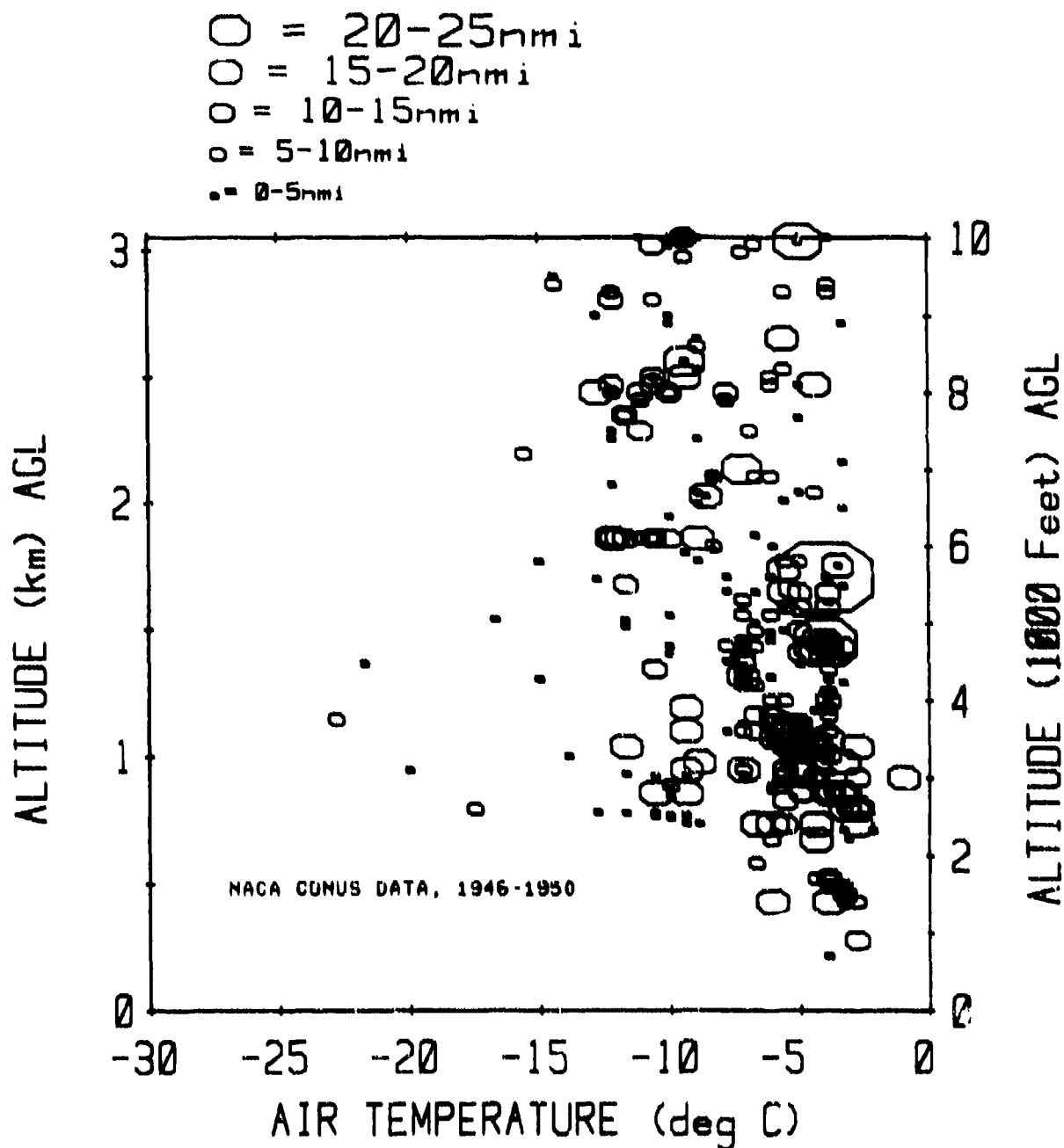


FIGURE 30. SCATTERPLOT OF ICING EVENT TEMPERATURES VS. ALTITUDE FOR NACA DATA FROM SUPERCOOLED LAYER CLOUDS (St, Sc, Ns, As, Ac) UP TO 10,000 FT AGL. The size of each symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each symbol corresponds to the average (and approximately constant) value of altitude and OAT observed during the icing event. A total of 2610 data miles is represented in this graph.

~~mynwac~~ = 20-25nmi
~~mynwac~~ = 15-20nmi
~~mynwac~~ = 10-15nmi
~~mynwac~~ = 5-10nmi
~~mynwac~~ = 0-5nmi

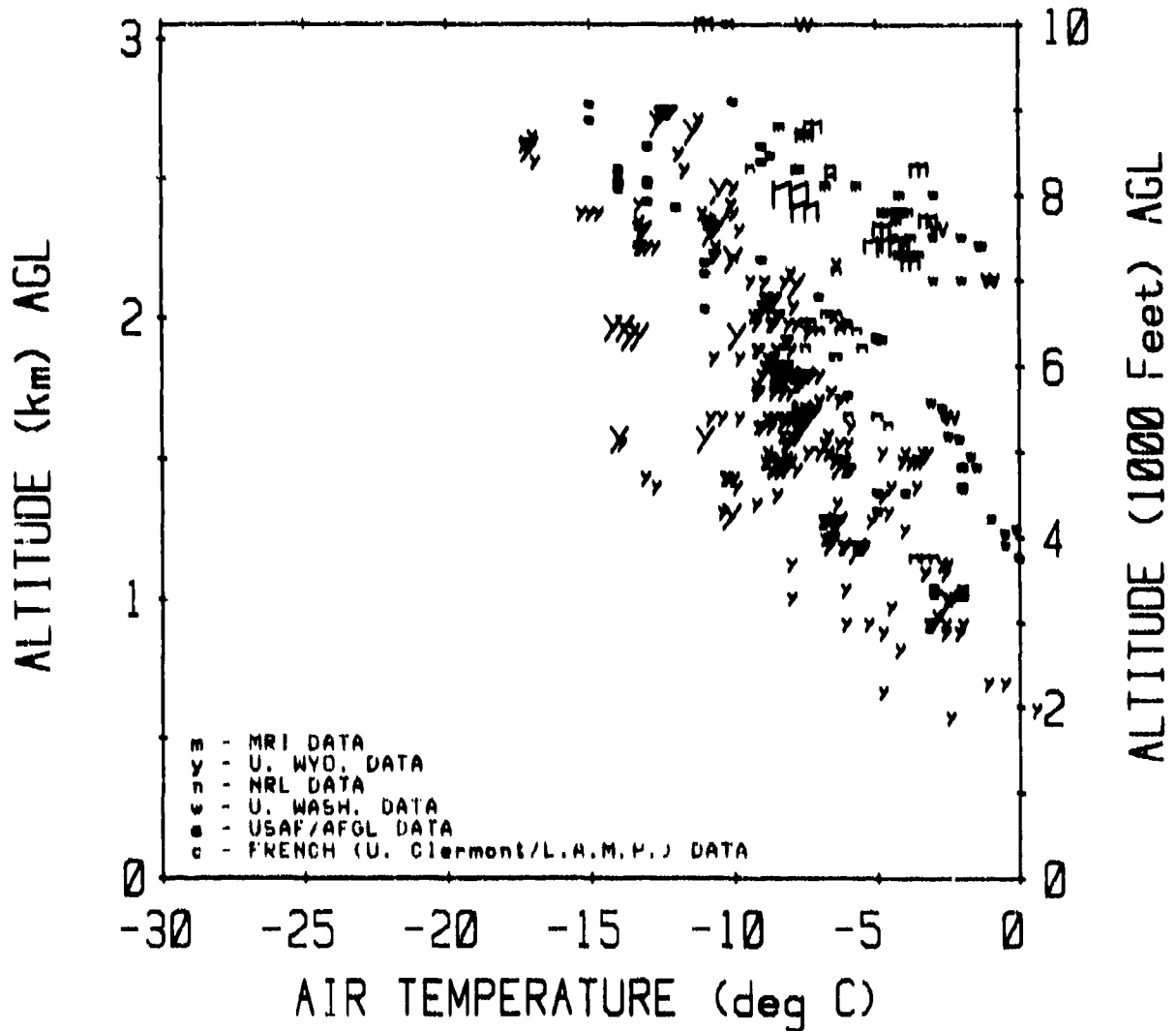


FIGURE 31. SCATTERPLOT OF ICING EVENT TEMPERATURES VS. ALTITUDE FOR MODERN DATA FROM SUPERCOOLED CONVECTIVE CLOUDS (Cu, Cb) UP TO 10,000 FT AGL. The various plotting symbols represent different data sources as indicated in the key. The size of each symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each symbol corresponds to the average (and approximately constant) value of altitude and OAT observed during the icing event. A total of 980 data miles is represented in this graph.

○ = 20-25nmi
 ○ = 15-20nmi
 ○ = 10-15nmi
 ○ = 5-10nmi
 ● = 0-5nmi

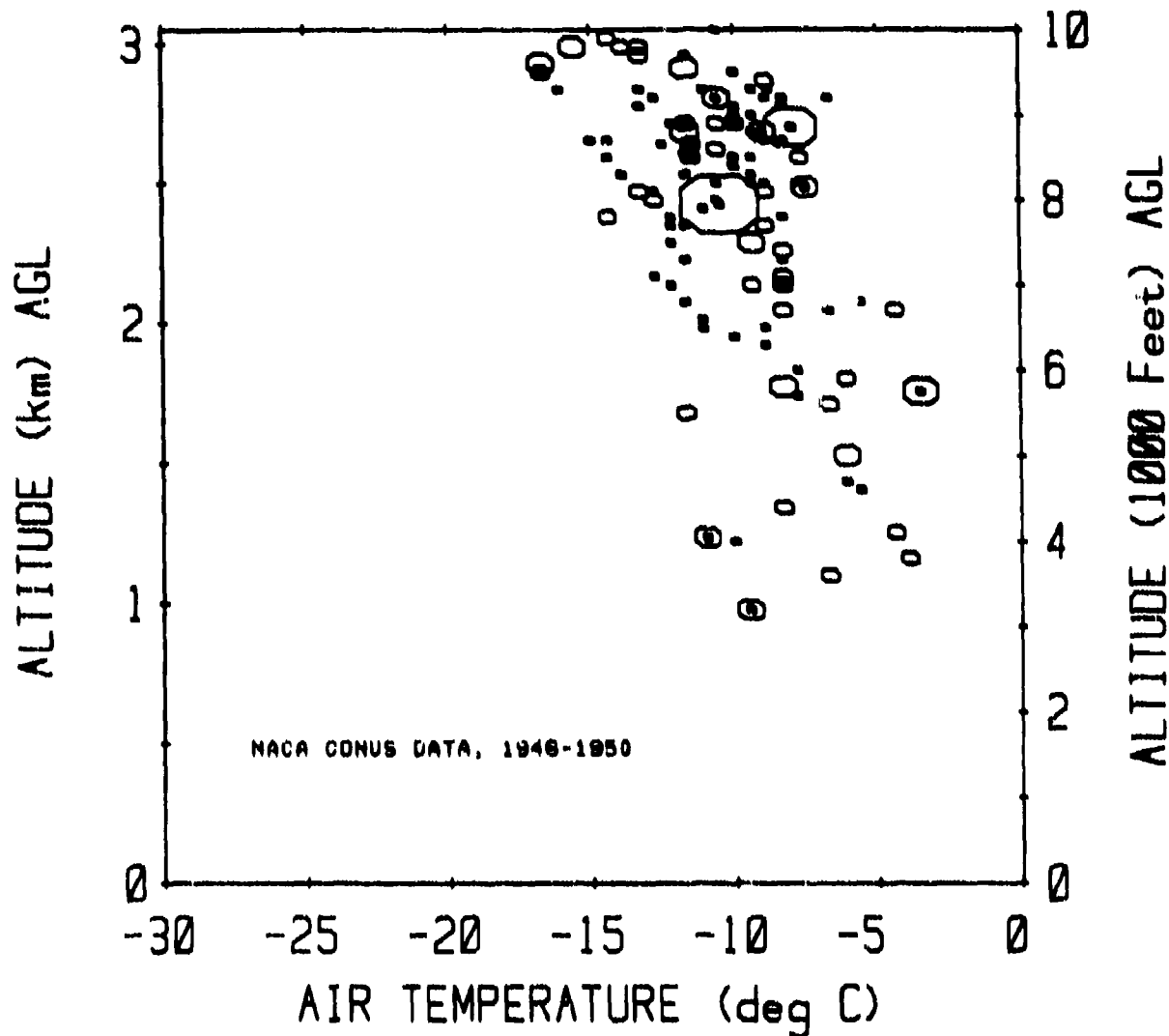


FIGURE 32. SCATTERPLOT OF ICING EVENT TEMPERATURES VS. ALTITUDE FOR NACA DATA FROM SUPERCOOLED CONVECTIVE CLOUDS (Cu, Cb) UP TO 10,000 FT AGL. The size of each symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each symbol corresponds to the average (and approximately constant) value of altitude and OAT observed during the icing event. A total of 620 data miles is represented in this graph.

$mynwac = 20-25nmi$
 $mynwac = 15-20nmi$
 $mynwac = 10-15nmi$
 $mynwac = 5-10nmi$

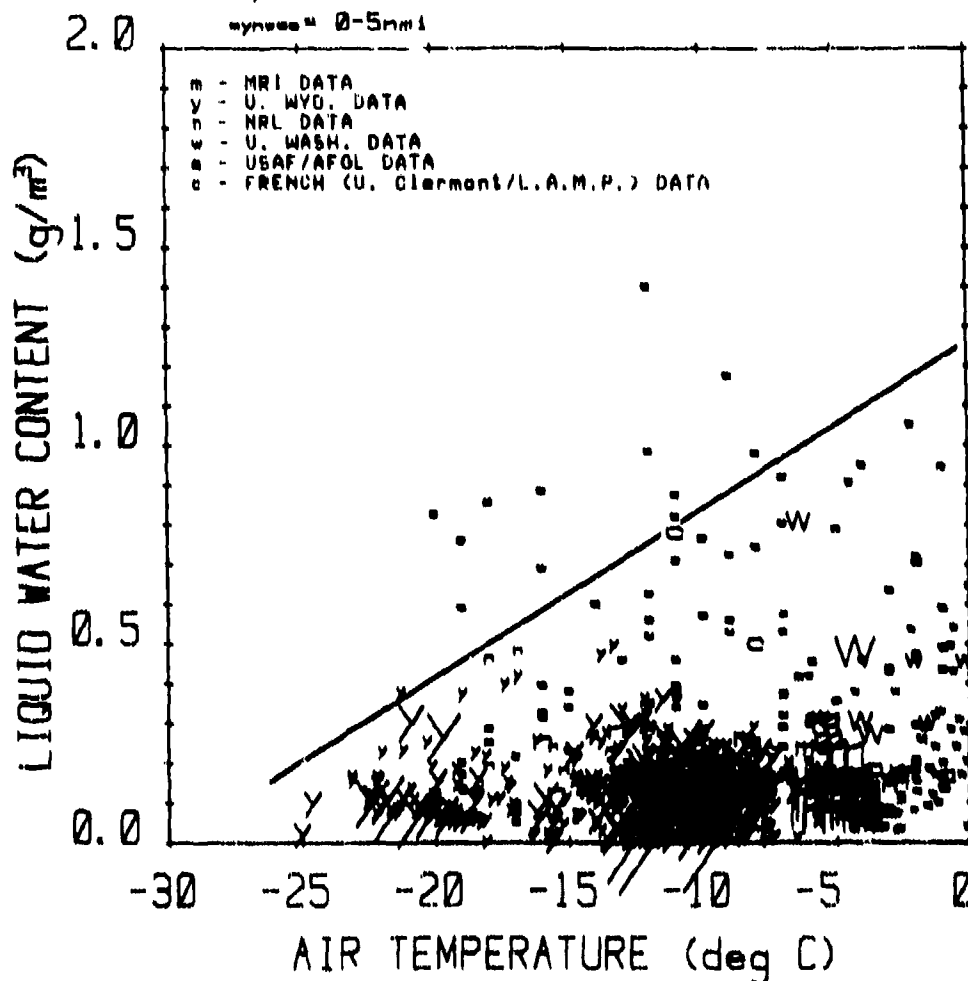


FIGURE 33. SCATTERPLOT OF LWC VS. OAT FOR MODERN DATA FROM SUPERCOOLED LAYER CLOUDS (St, Sc, Ns, As, Ac) UP TO 10,000 FT AGL. The various plotting symbols represent different data sources as indicated in the key. The size of each symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each symbol corresponds to the average (and approximately constant) value of LWC and OAT observed during the icing event. The solid line represents the apparent upper limit to LWC as a function of temperature for CONUS supercooled layer clouds below 10,000 ft AGL. The position of the line is based on the maximum LWC values in the combined NACA and modern CONUS data sets. A total of 2660 data miles is represented in this graph.

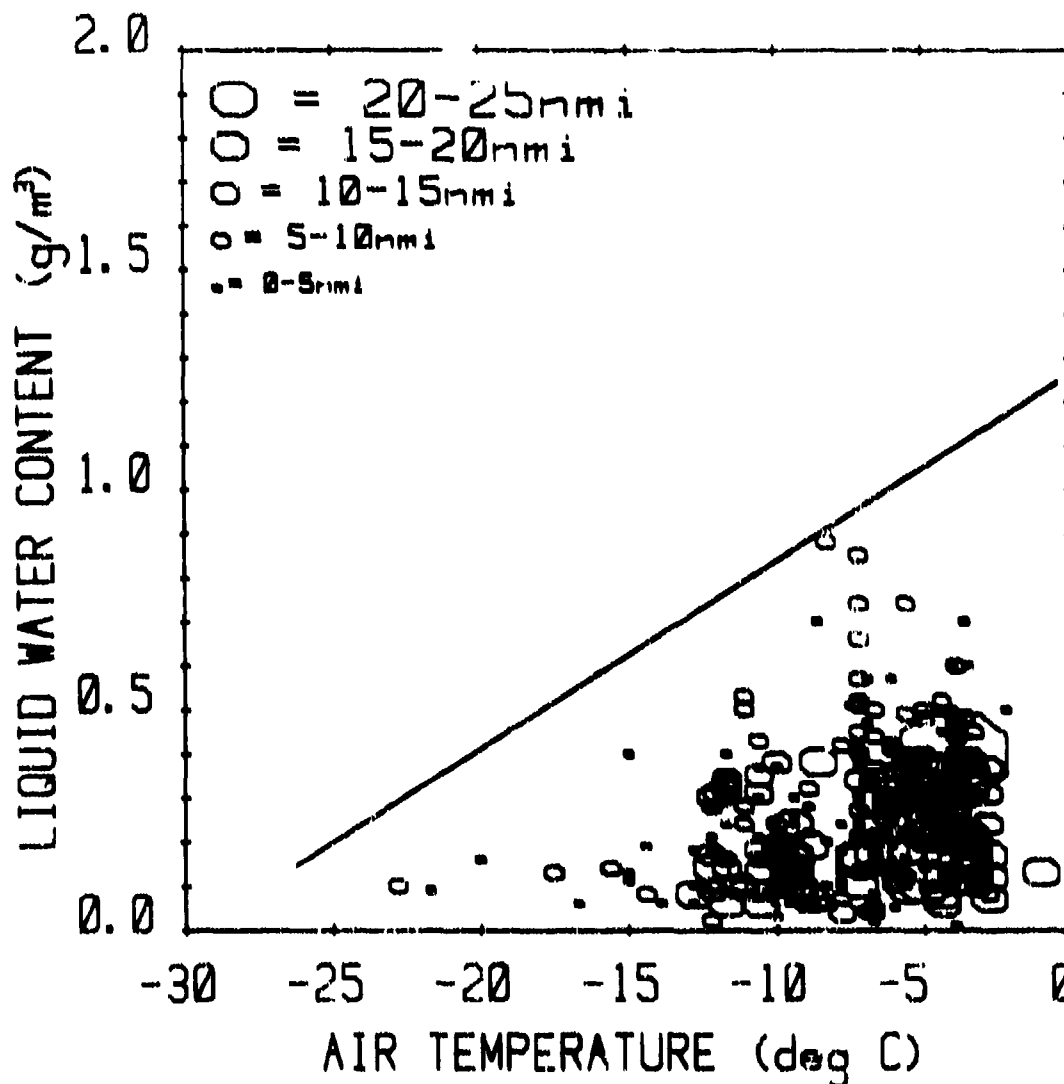


FIGURE 34. SCATTERPLOT OF LWC VS. OAT FOR NACA (1946-1950) DATA FROM SUPERCOOLED LAYER CLOUDS (St, Sc, Ns, As, Ac) UP TO 10,000 FT AGL. The size of each symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each symbol corresponds to the average (and approximately constant) value of LWC and OAT observed during the icing event. The solid line bounding the data points represents the apparent upper limit to LWC as a function of temperature for CONUS supercooled layer clouds below 10,000 ft AGL. The position of the line is based on the maximum LWC values in the combined NACA and modern data sets. A total of 7610 data miles is represented in this graph.

~~mynwac~~ = 20-25nmi
~~mynwac~~ = 15-20nmi
~~mynwac~~ = 10-15nmi
~~mynwac~~ = 5-10nmi
~~mynwac~~ = 0-5nmi

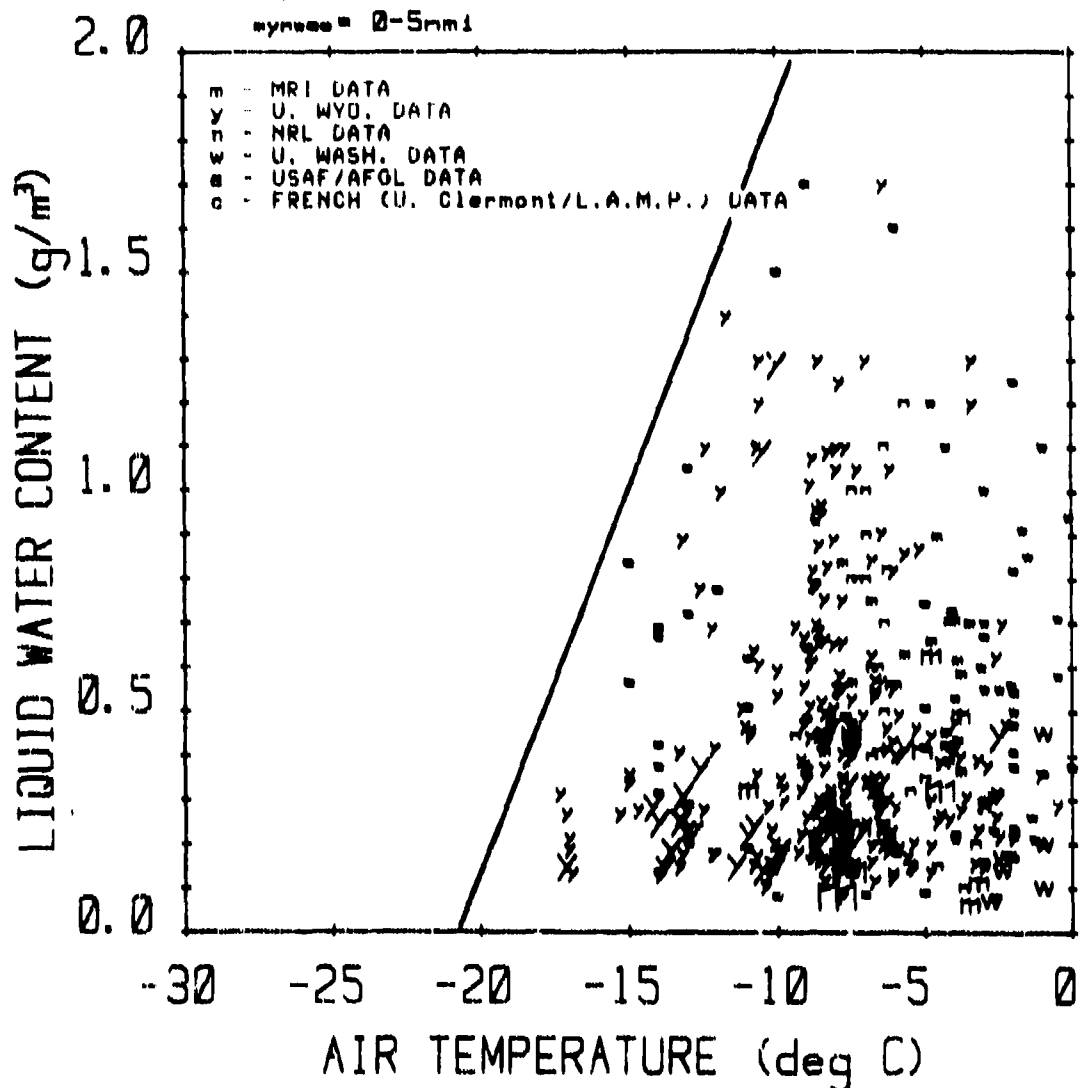


FIGURE 35. SCATTERPLOT OF LWC VS. OAT FOR MODERN DATA FROM SUPERCOOLED CONVECTIVE CLOUDS (Cu, Ch) UP TO 10,000 FT AGL. The various plotting symbols represent different data sources as indicated in the key. The size of each symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each symbol corresponds to the average (and approximately constant) value of LWC and OAT observed during the icing event. The solid line bounding the data points represents the apparent upper limit to LWC as a function of temperature for CONUS supercooled convective clouds below 10,000 ft AGL. The position of the line is based on the maximum LWC values in the combined NACA and modern data sets. A total of 980 data miles is represented in this graph.

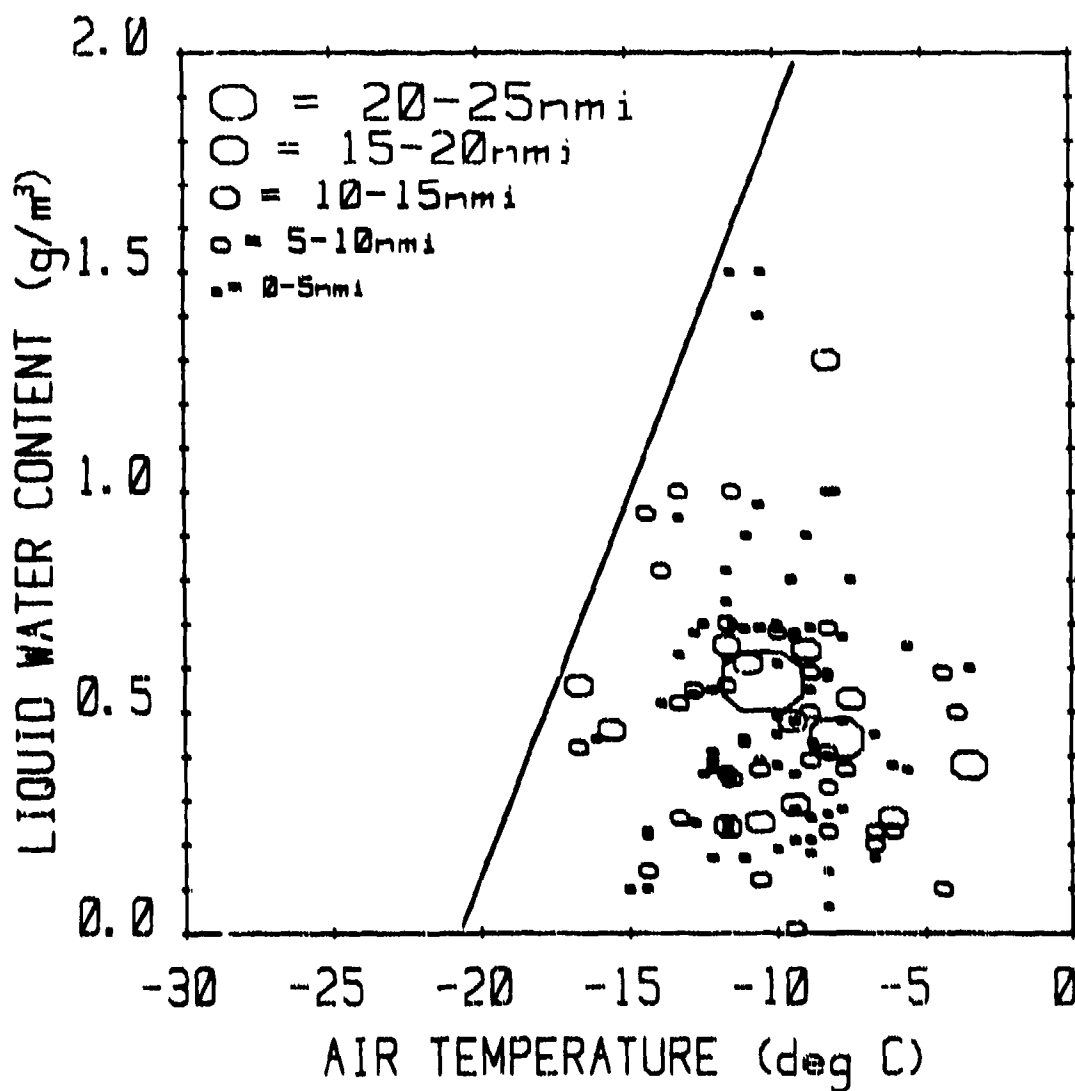


FIGURE 36. SCATTERPLOT OF LWC VS. OAT FOR NACA (1946-1950) DATA FROM SUPERCOOLED CONVECTIVE CLOUDS (Cu, Cb) UP TO 10,000 FT AGL. The size of each symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each symbol corresponds to the average (and approximately constant) value of LWC and OAT observed during the icing event. The solid line bounding the data points represents the apparent upper limit to LWC as a function of temperature for CONUS supercooled convective clouds below 10,000 ft AGL. The position of the line is based on the maximum LWC values in the combined NACA and modern data sets. A total of 620 data miles is represented in this graph.

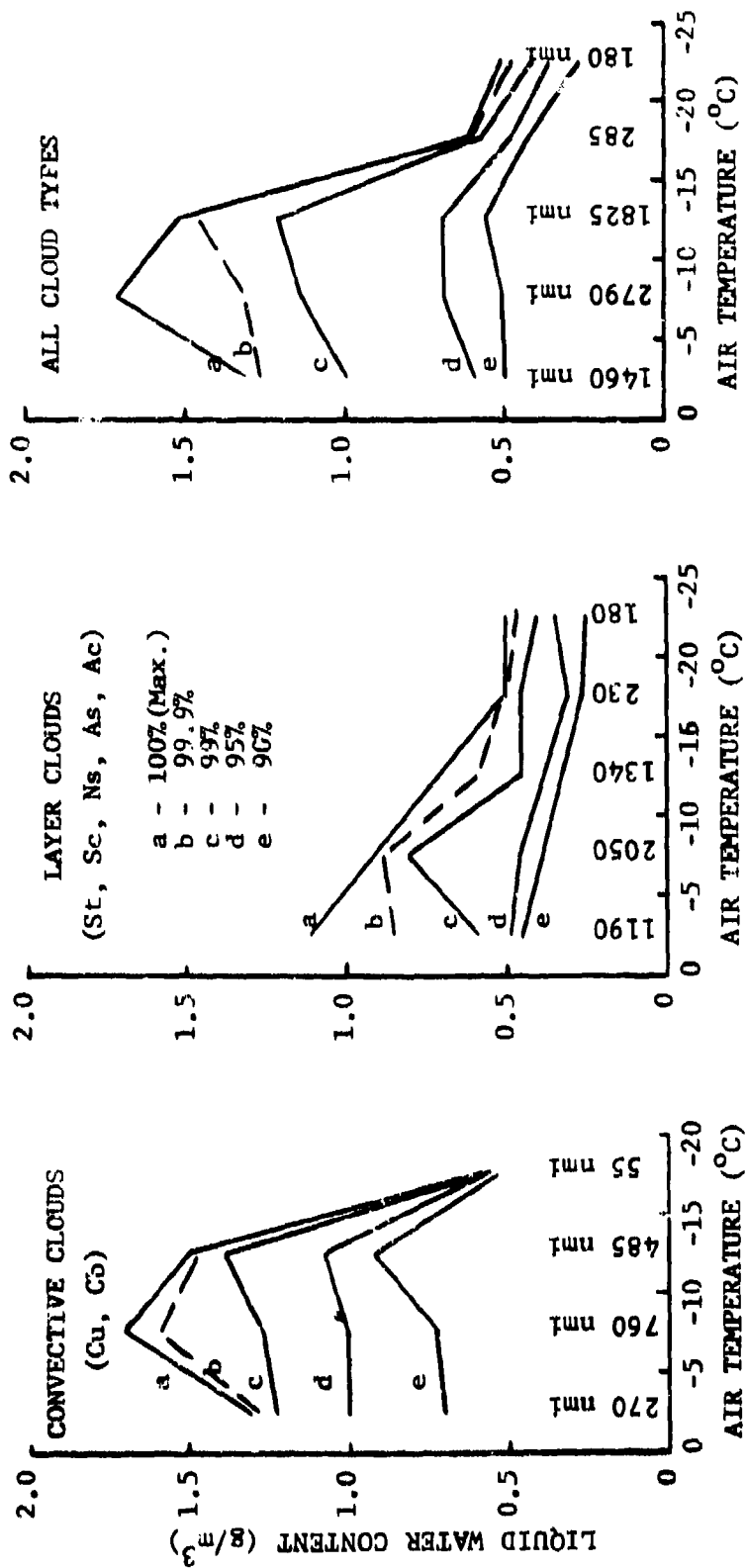


FIGURE 37. SELECTED, CUMULATIVE FREQUENCIES OF OCCURRENCE OF LWC VS. TEMPERATURE FOR THE ENTIRE CONUS DATA BASE. The n th percentile curves indicate the value of LWC that was exceeded in $n\%$ of the data miles recorded for the indicated temperature interval and cloud category. The number of data miles contributing to each 5°C temperature interval is given in each temperature interval.

$mynwac = 20-25nm$
 $mynwac = 15-20nm$
 $mynwac = 10-15nm$
 $mynwac = 5-10nm$
 $mynwac = 0-5nm$

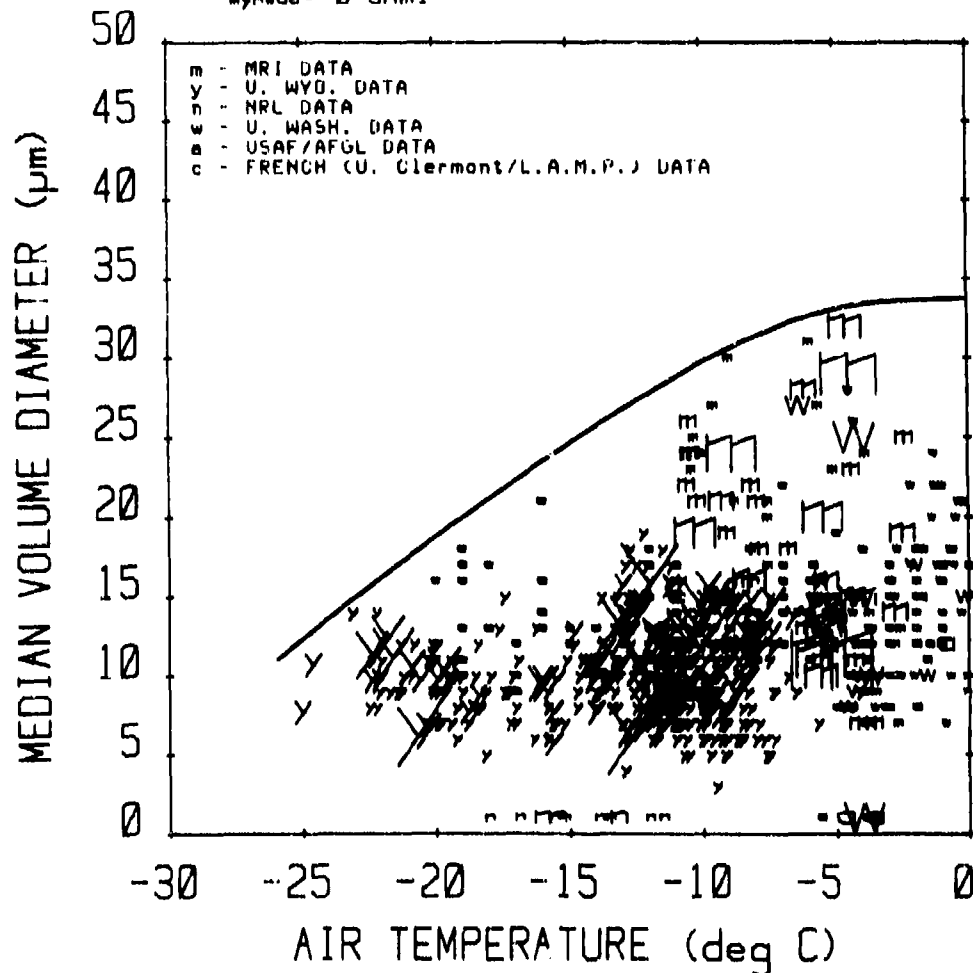


FIGURE 38. SCATTERPLOT OF MVD VS. OAT FOR MODERN DATA FROM SUPERCOOLED LAYER CLOUDS (St, Sc, Ns, As, Ac) UP TO 10,000 FT AGL. The various plotting symbols represent different data sources as indicated in the key. The size of each symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each symbol corresponds to the average (and approximately constant) value of MVD and OAT observed during the icing event. The solid line bounding the data points represents the apparent upper limit to MVD as a function of temperature for supercooled layer clouds below 10,000 ft AGL. The position of the line at temperatures above $-15^{\circ}C$ is based on the maximum MVDs in the modern data only, but below $-15^{\circ}C$ the line is based on maximum MVDs from both the NACA and modern data sets. The data points plotted at $1 \mu m$ MVD are those for which the MVD values are actually unknown. A total of 2660 data miles is represented in this graph.

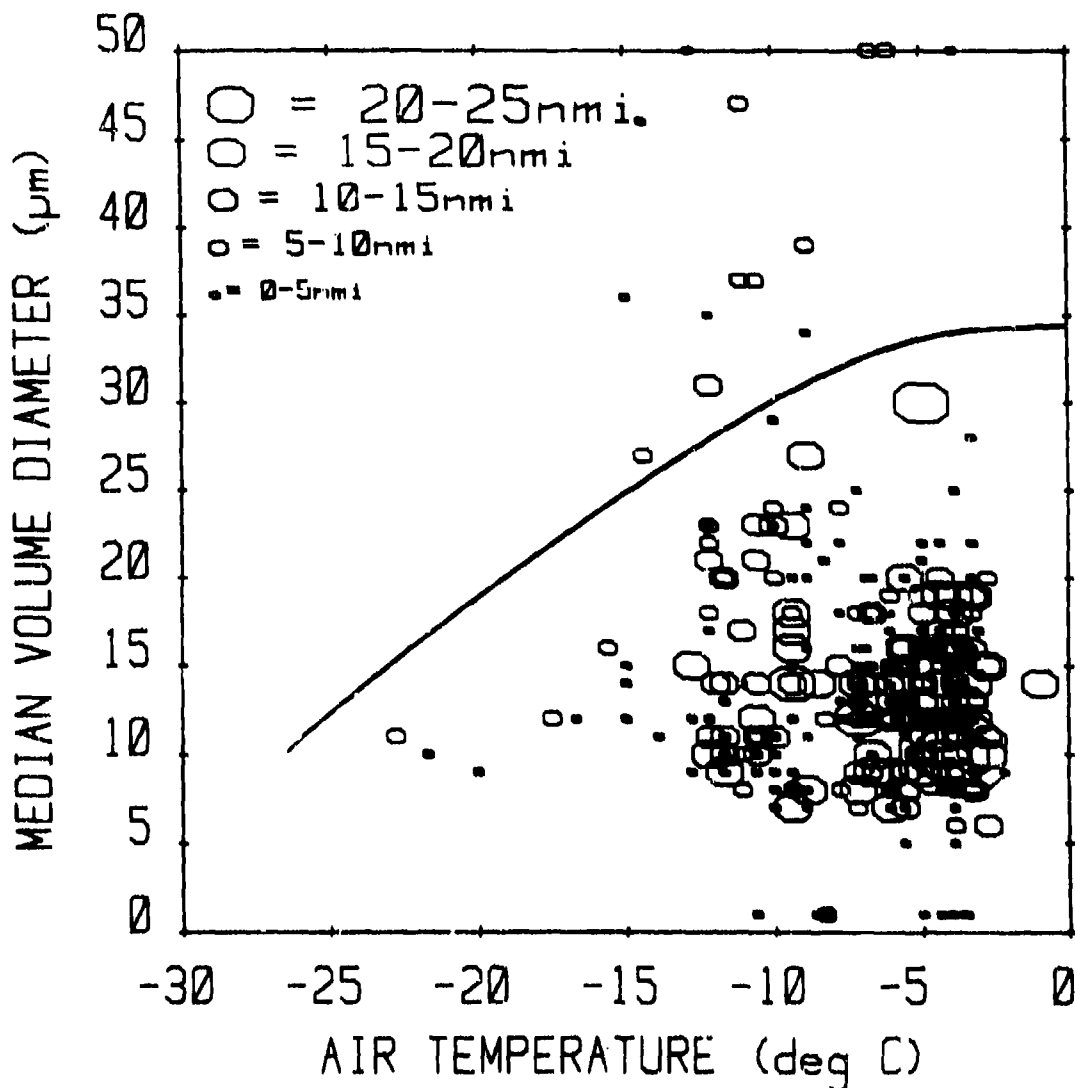


FIGURE 39. SCATTERPLOT OF MVD VS. OAT FOR NACA (1946-1950) DATA FROM SUPERCOOLED LAYER CLOUDS (St, Sc, Ns, As, Ac) UP TO 10,000 FT AGL. The size of each symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each symbol corresponds to the average (and approximately constant) value of MVD and OAT observed during the icing event. The solid line through the data points represents the apparent upper limit to MVD as a function of temperature for supercooled layer clouds below 10,000 ft AGL. The position of the line at temperatures above -15°C is based on the maximum MVDs in the modern data only, but below -15°C the line is based on maximum MVDs from both the NACA and modern data sets. The data points plotted at $1\text{ }\mu\text{m}$ MVD are those for which the MVD values are actually unknown. A total of 2610 data miles is represented in this graph.

~~mynwac~~ = 20-25nmi
~~mynwac~~ = 15-20nmi
~~mynwac~~ = 10-15nmi
~~mynwac~~ = 5-10nmi
~~mynwac~~ = 0-5nmi

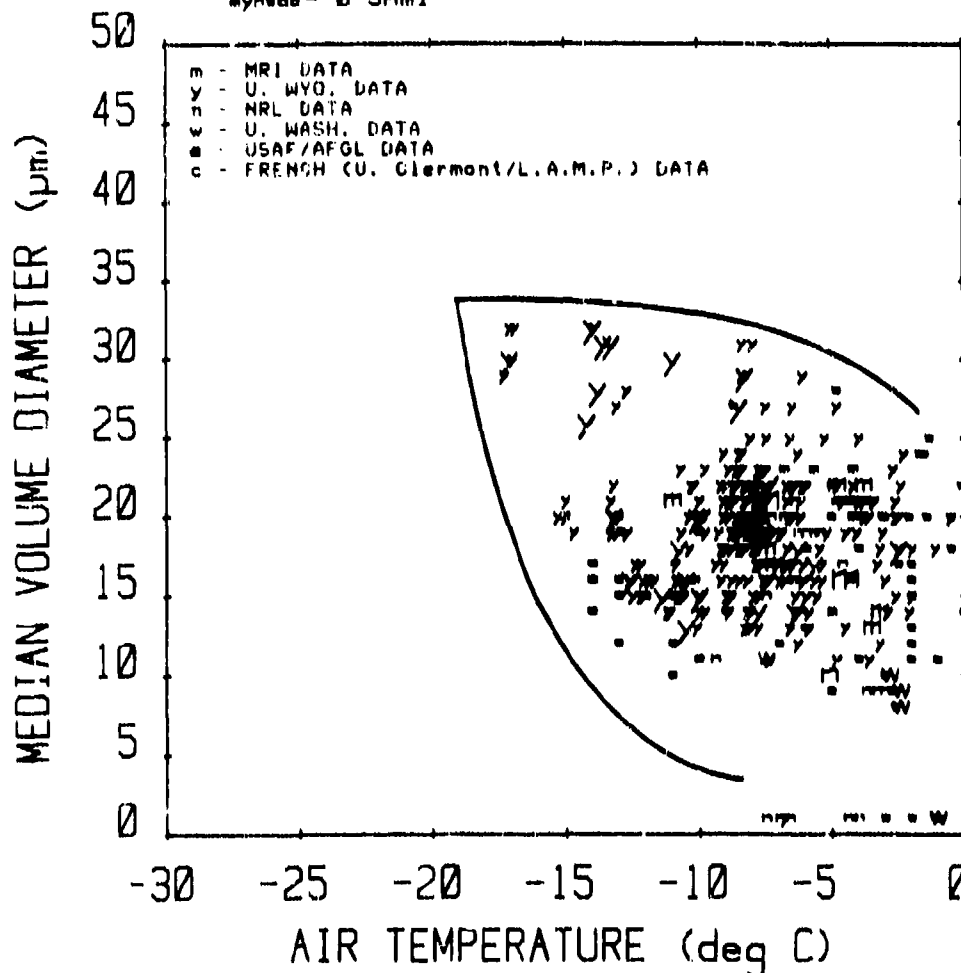


FIGURE 40. SCATTERPLOT OF MVD VS. OAT FOR MODERN DATA FROM SUPERCOOLED CONVECTIVE CLOUDS (Cu, Cb) UP TO 10,000 FT AGL. The various plotting symbols represent different data sources as indicated in the key. The size of each symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each symbol corresponds to the average (and approximately constant) value of MVD and OAT observed during the icing event. The solid line bounding the data points represents the apparent upper and lower limit to MVD as a function of temperature for supercooled convective clouds below 10,000 ft AGL. The position of the line is based on extreme MVD values in both the NACA and modern data sets. The data points plotted at 1 μm MVD are those for which the MVD values are actually unknown. A total of 980 data miles is represented in this graph.

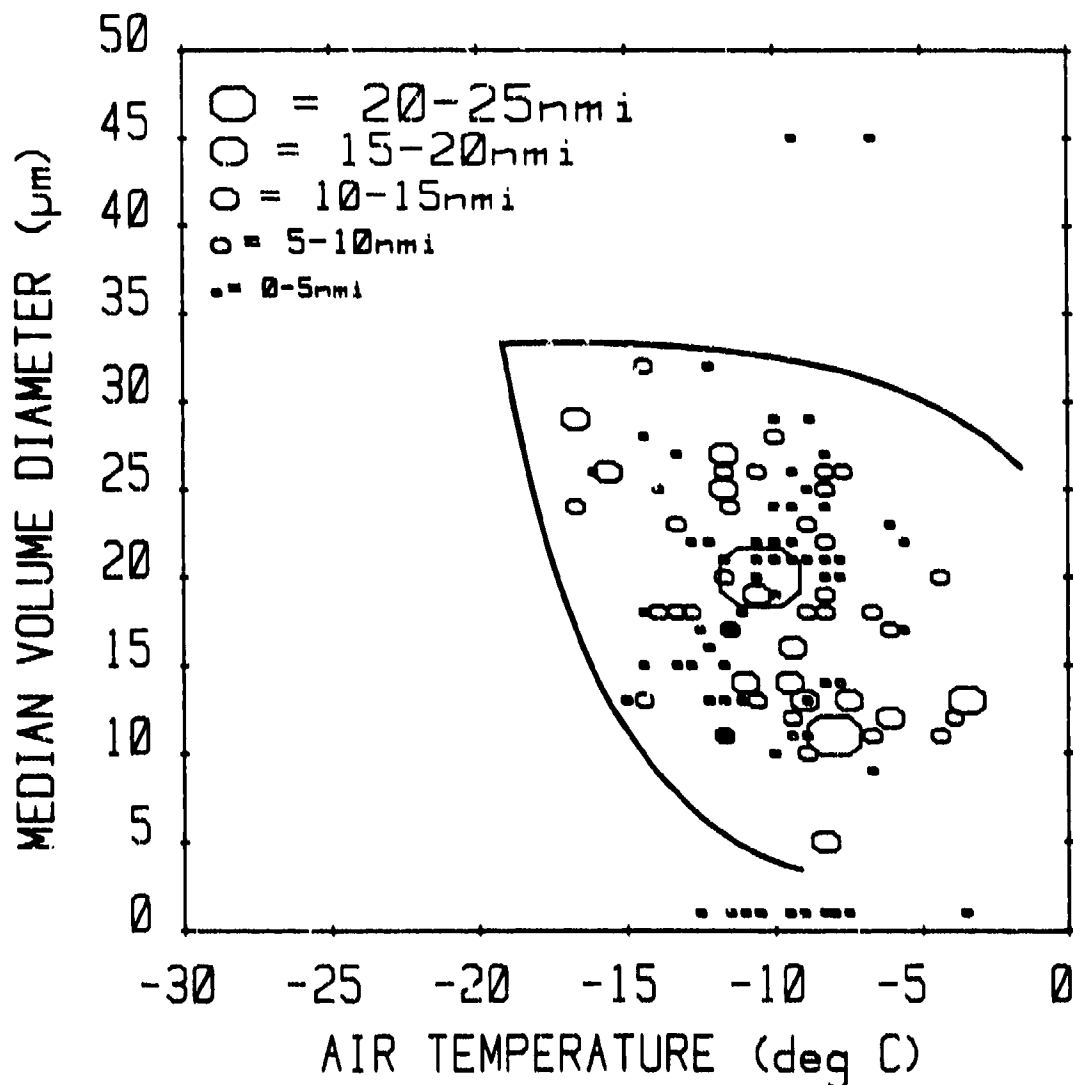


FIGURE 41. SCATTERPLOT OF MVD VS. OAT FOR NACA (1946-1950) DATA FROM SUPERCOOLED CONVECTIVE CLOUDS (Cu, Cb) UP TO 10,000 FT AGL. The size of each symbol is proportional to its statistical weight (i.e., the observed horizontal extent of the associated icing event) as shown by the scale above the graph. The center of each symbol corresponds to the average (and approximately constant) value of MVD and OAT observed during the icing event. The solid line bounding the data points represents the apparent upper and lower limit to MVD as a function of temperature for supercooled convective clouds below 10,000 ft AGL. The position of the line is based on extreme MVD values in both the NACA and modern data sets. The data points plotted at 1 μm MVD are those for which the MVD values are actually unknown. A total of 620 data miles is represented in this graph.

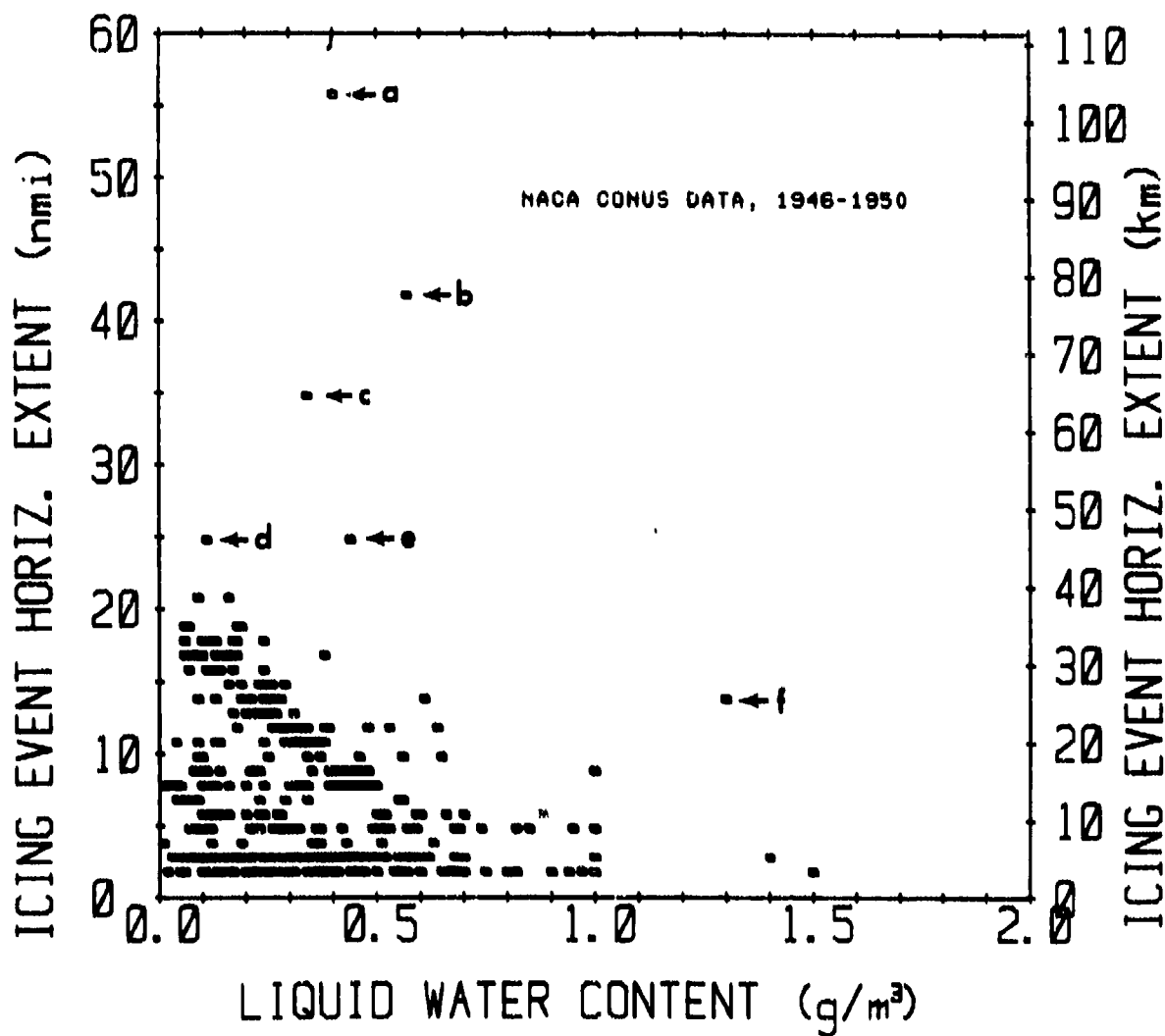


FIGURE 42. SCATTERPLOT OF NACA OBSERVED HORIZONTAL EXTENTS OF INDIVIDUAL ICING EVENTS VS. AVERAGE LWC OVER THE EVENT. Data are from all supercooled cloud types up to 10,000 ft AGL and for all observed cloud temperatures below 0°C . Extreme values, labeled a through f, are analyzed individually in the HORIZONTAL EXTENT section of the text. A total of 3200 data miles is represented in this graph.

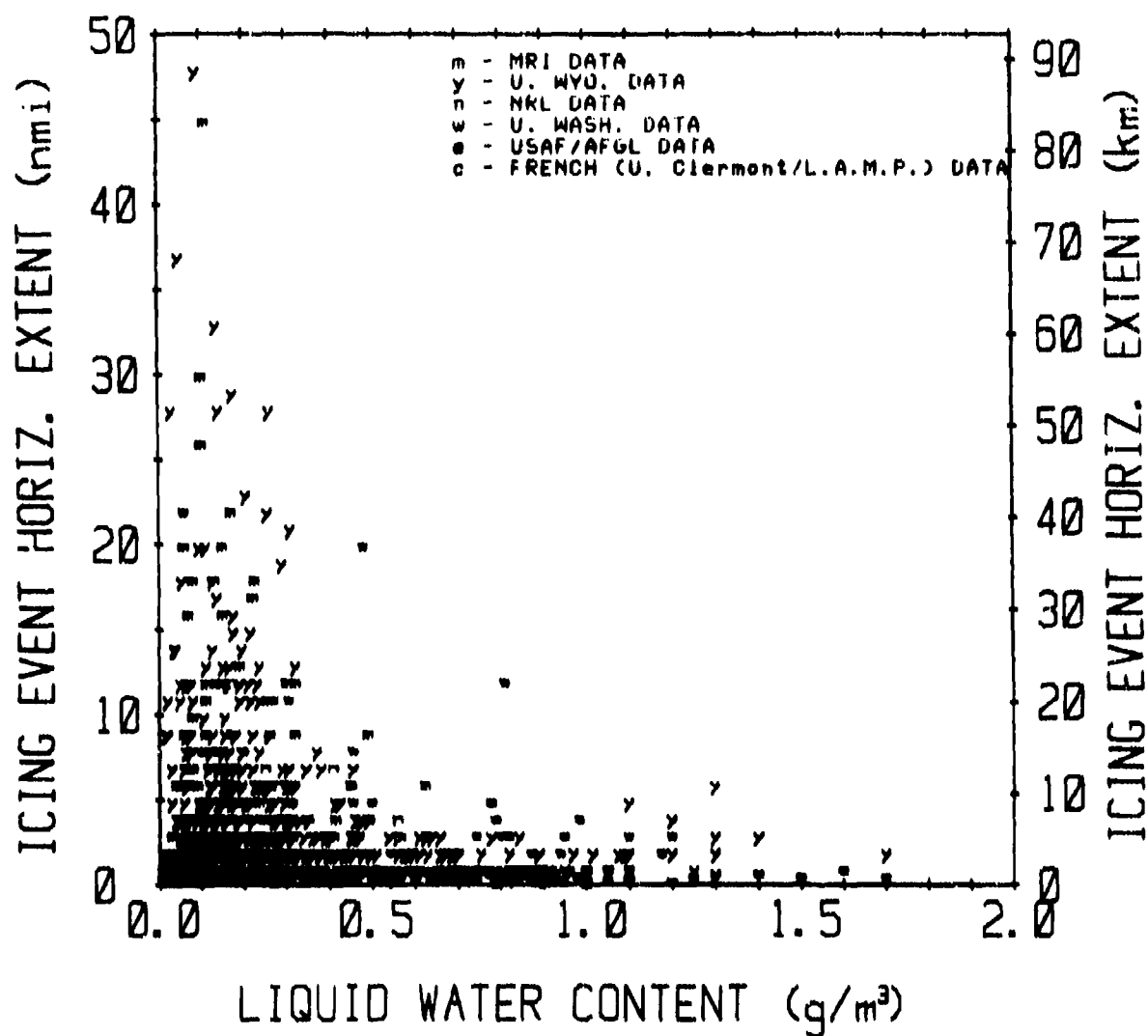


FIGURE 43. SCATTERPLOT OF MODERN OBSERVED HORIZONTAL EXTENTS OF INDIVIDUAL ICING EVENTS VS. AVERAGE LWC OVER THE EVENT. Data are from all supercooled cloud types below 10,000 ft AGL and for all observed cloud temperatures below 0°C. A total of 3645 data miles is represented in this graph. The different plotting symbols represent different data sources as indicated in the key.

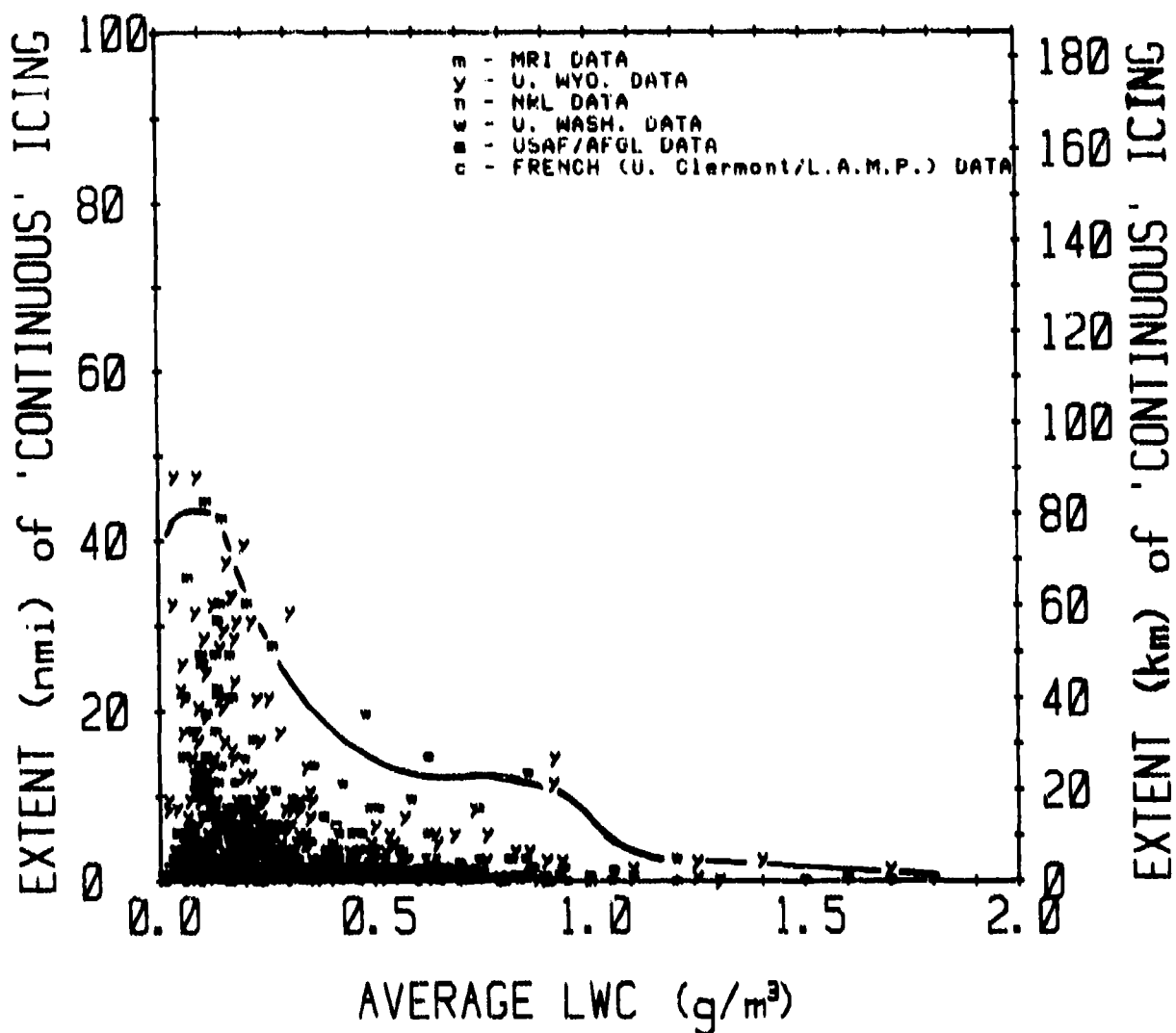


FIGURE 44. SCATTERPLOT OF MODERN OBSERVED HORIZONTAL EXTENTS OF ENTIRE ICING ENCOUNTERS VS. AVERAGE LWC OVER THE ENCOUNTER. In this figure an icing encounter is defined as a series of one or more icing events traversed consecutively until a cloud gap of 1 nmi or more is reached. The horizontal extent of the encounter is the sum of the horizontal extents of the component icing events but does not include the extent of permissible cloud gaps. Data are for all supercooled cloud types at altitudes up to 10,000 ft AGL and for all observed cloud temperatures below 0°C. A total of 3643 data miles is represented in this graph. The different plotting symbols represent different data sources as indicated in the key. The curved line is the 99th percentile of horizontal extent for these encounters as a function of average LWC.

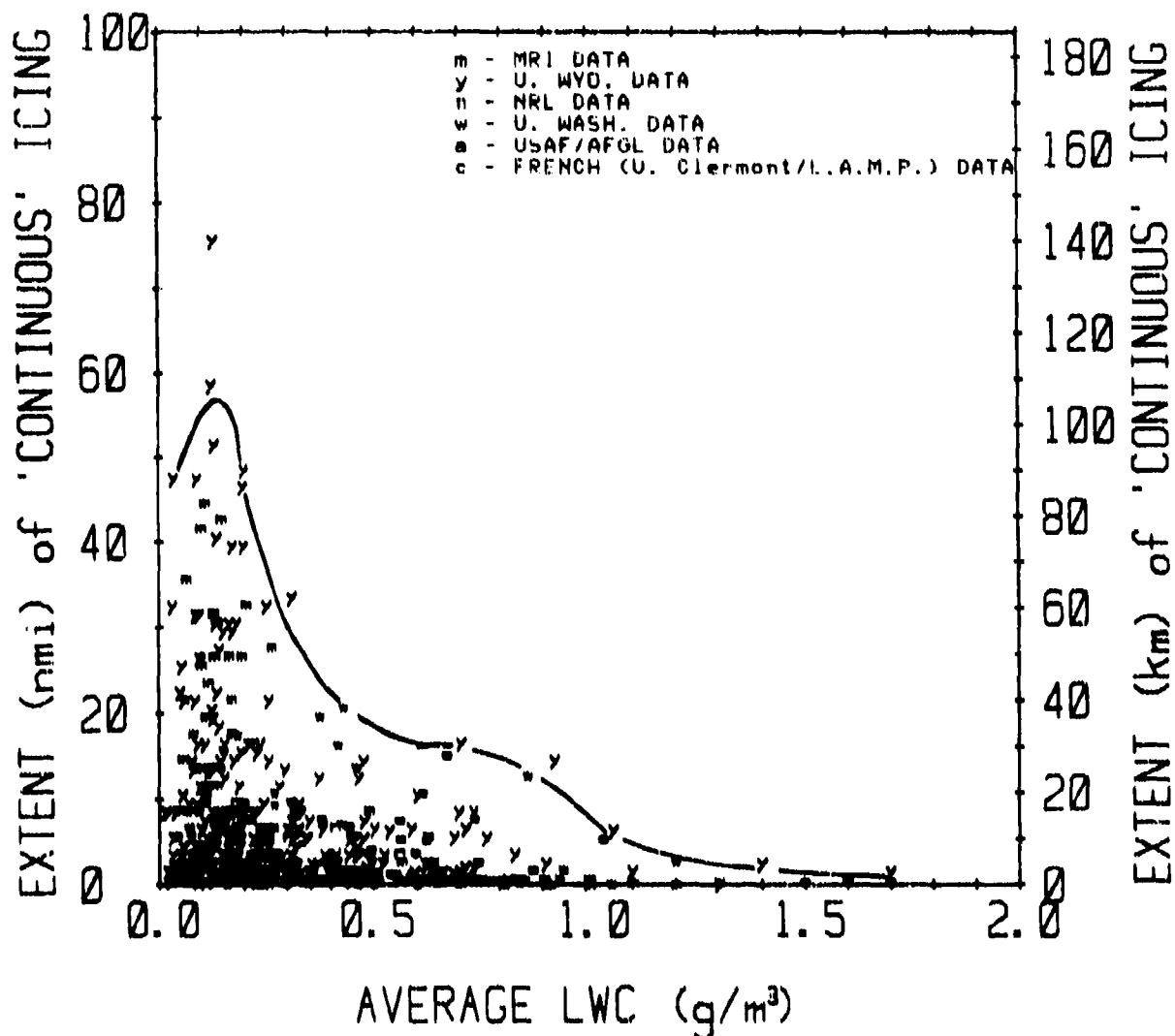


FIGURE 45. SCATTERPLOT OF MODERN OBSERVED HORIZONTAL EXTENTS OF ENTIRE ICING ENCOUNTERS VS. AVERAGE LWC OVER THE ENCOUNTER. In this figure an icing encounter is defined as a series of one or more icing events traversed consecutively until a cloud gap of 3 nmi or more is reached. The horizontal extent of the encounter is the sum of the horizontal extents of the component icing events but does not include the extent of permissible cloud gaps. Data are for all supercooled cloud types at altitudes up to 10,000 ft AGL and for all observed cloud temperatures below 0°C. A total of 3645 data miles is represented in this graph. The different plotting symbols represent different data sources as indicated in the key. The curved line is the 99th percentile of horizontal extent for these encounters as a function of average LWC.

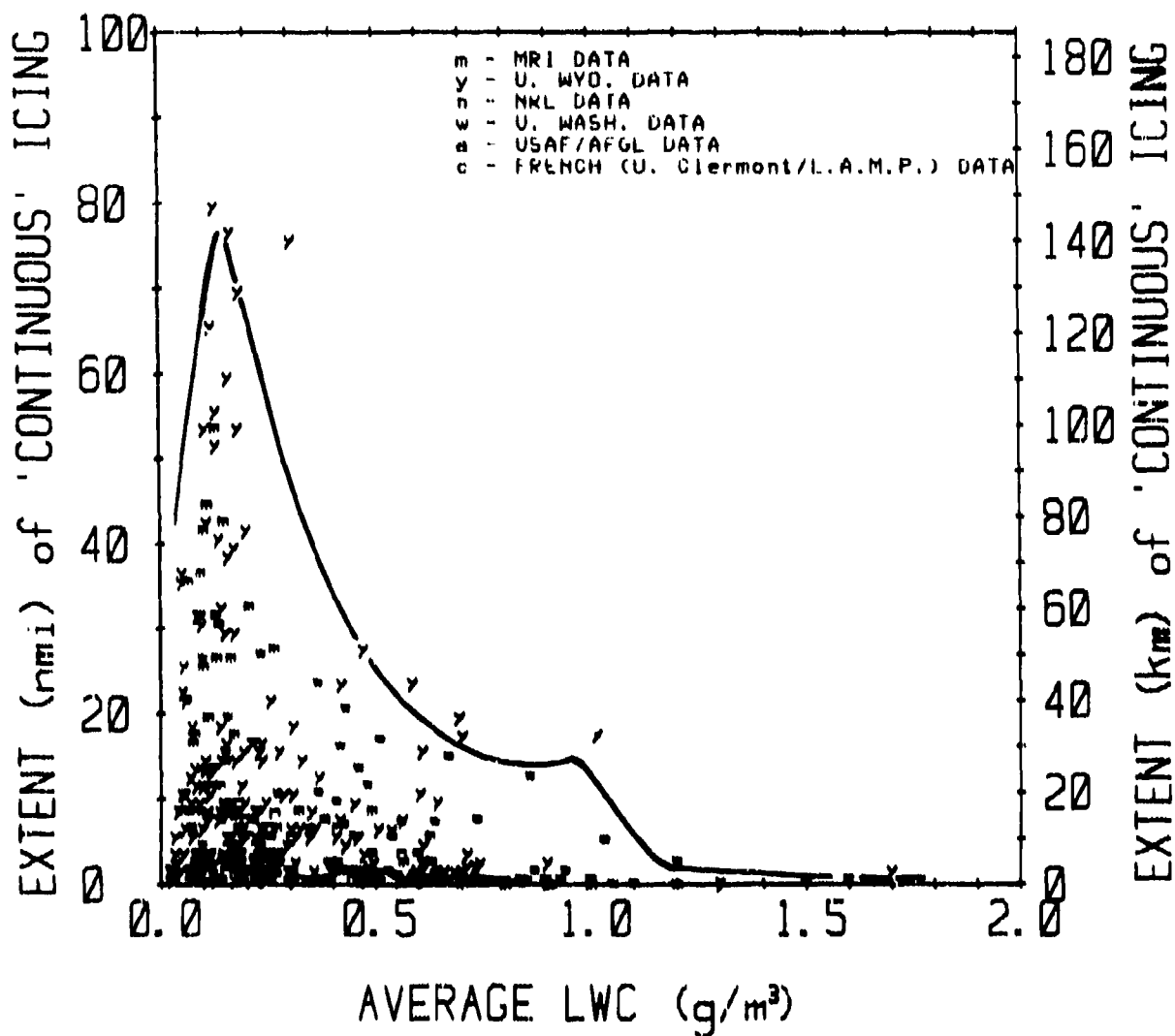


FIGURE 46. SCATTERPLOT OF MODERN OBSERVED HORIZONTAL EXTENTS OF ENTIRE ICING ENCOUNTERS VS. AVERAGE LWC OVER THE ENCOUNTER. In this figure an icing encounter is defined as a series of one or more icing events traversed consecutively until a cloud gap of 10 nmi or more is reached. The horizontal extent of the encounter is the sum of the horizontal extents of the component icing events but does not include the extent of permissible cloud gaps. Data are for all supercooled cloud types at altitudes up to 10,000 ft AGL and for all observed cloud temperatures below 0°C. A total of 3645 data miles is represented in this graph. The different plotting symbols represent different data sources as indicated in the key. The curved line is the 99th percentile of horizontal extent for these encounters as a function of average LWC.

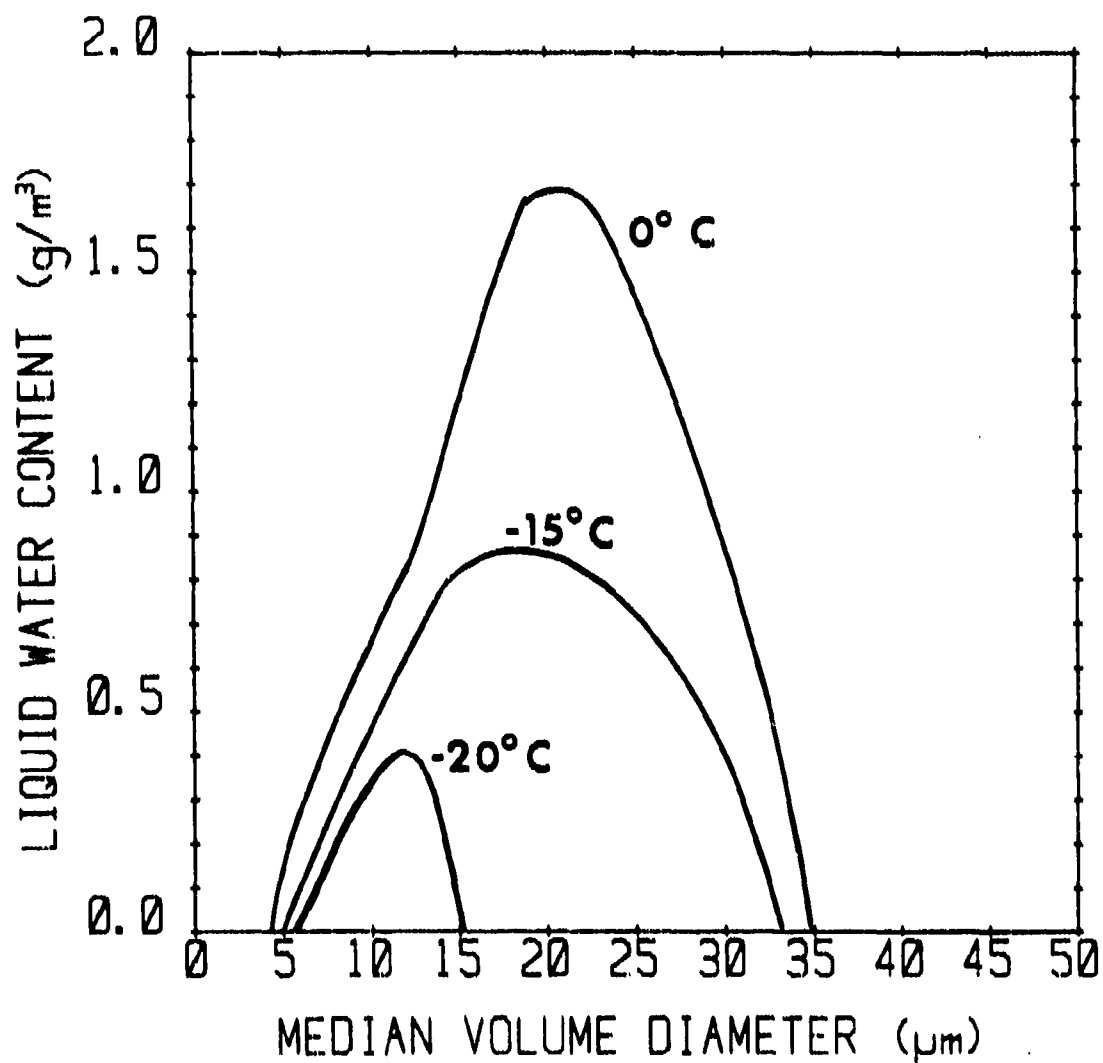


FIGURE 47. APPROXIMATE EXTREME VALUES OF LWC AND MVD COMBINATIONS OBSERVED IN SUPERCOOLED CLOUDS AT ALTITUDES UP TO 10,000 FT AGL. The curved lines here represent the approximate extreme values of LWC and MVD observed in any supercooled cloud icing event up to 10,000 ft AGL and up to the temperatures indicated.

APPENDIX A

THE NEW DATA BASE FOR SUPERCOOLED CLOUDS UP TO 10,000 FT AGL

This appendix contains the following information.

1. The DATA CODING SCHEME (Table A-1) -- a list of the items included in the Data Base and their arrangement on an 80-column punched card format. Each icing event requires two 80-column records (i.e., two punched cards, or their equivalent on digital magnetic tape). The first card or leading card, contains general information about the flight, the cloud or cloud system in which the measurements took place, and the associated weather situation. The second or "type 2" card contains specific data such as LWC, MVD, etc., averaged over a specific icing event defined by the "Rules for Defining Uniform Cloud Intervals" given in Table 1 of the text. Usually there is more than one identifiable icing event in a given cloud (or cloud system) in which case there are several "type 2" data cards following a common leading card. This group of cards, consisting of a leading card followed by one or more "type 2" data cards is referred to as a data suite.

2. The CODE SYMBOL EXPLANATION (Table A-2) -- an item-by-item explanation of the data entries, the selection of alphanumeric symbols that are allowable for coding the data into the card columns, and the format for entering the symbols into the assigned card columns. Examples are given in many cases for purposes of illustration.

3. The LIST OF CODE SYMBOLS (Table A-3).

4. The NEW SUPERCOOLED CLOUD DATA BASE (Table A-4) -- a complete listing of the coded Data Base as it exists at this writing. Additions are anticipated in the near future as more data, already in existence, are made available. These additions are expected to include data from clouds along cold fronts and in cyclonic storms, orographic clouds, Mt. Washington (New Hampshire) Observatory measurements, and some modern European airborne measurements.

TABLE A-1. DATA CODING SCHEME

First Card of each Data Suite

| <u>Item</u> | <u>Code</u> | <u>Card Columns</u> |
|--|-------------|---------------------|
| Mission Identifier (Flight No. or Cloud No.) | XXXXXXX | 1-7 |
| Date of Measurement | MMDDYY | 8-13 |
| Geographic Location | GG or GGG | 14-16 |
| Source of Data: | | |
| Agency | LLL or LLLL | 17-20 |
| Reference (Publication ID or Report No.) | ZZ ----- ZZ | 21-36 |
| Altitude Reporting Convention: | | |
| Scale used for data in this suite | A | 37 |
| Elevation of local surface (hundreds of feet, ASL) | FF or M | 38-39 |
| Cloud Information: | | |
| Cloud type | CC or CCCc | 40-43 |
| Uniformity | G | 44 |
| Cloud base altitude (hundreds of feet) | BBB | 45-47 |
| Cloud base temperature (°C) | +WW.W | 48-52 |
| Cloud top altitude (hundreds of feet) | HHH | 53-55 |
| Cloud top temperature (°C) | -YY.Y | 56-60 |
| Weather Factors: | | |
| Airmass type | aAa or Ma | 61-63 |
| Weather description | cc --- cc | 64-79 |
| Card 1 indicator | 1 | 80 |

Second and Following Cards of each Data Suite

| <u>Item</u> | <u>Code</u> | <u>Card Columns</u> |
|------------------------------|-------------|---------------------|
| Time of Day for Event | hhmm+h | 1-6 |
| Icing Event Information: | | |
| Event No | ee | 7-8 |
| Defining criterion | f | 9 |
| Duration (min.) | mm or .m | 10-11 |
| Distance in cloud (nmi) | dd or .d | 12-13 |
| Aircraft State during Event: | | |
| Sampling maneuver | n | 14 |
| Airspeed (kt) | vvv | 15-17 |
| Altitude (ft) | aaaaa | 18-22 |
| Outside Air temperature (°C) | +tt.t | 23-27 |
| LWC Meter Data: | | |
| LWC (g/m ³) | w.w or .ww | 28-30 |
| Probe ID | pp | 31-32 |

TABLE A-1. DATA CODING SCHEME (Continued)

| <u>Item</u> | <u>Code</u> | <u>Card Columns</u> |
|---|--------------|---------------------|
| Droplet Probe Data: | | |
| LWC (g/m^3) | W.W or .WW | 33-35 |
| MVD (μm) | UU | 36-37 |
| Max droplet diameter (μm) | ZZ | 38-39 |
| N (no/cc) | NNN | 40-42 |
| Probe ID | PP | 43-44 |
| Precipitation or Other Large Particle Probe Data: | | |
| PMS 2D-C Probe concentration (Particles per liter) | n.n or .nn | 45-47 |
| PMS 2D-P Probe " " " " | n.n or .nn | 48-50 |
| PMS 1D (OAP) Probe " " " | nn or .n | 51-52 |
| Other Ice Particle Counter " | nn or .n | 53-54 |
| Probe ID | P | 55 |
| Ice Meter Data: | | |
| LWC (g/m^3) | W.W or .WW | 56-58 |
| Iceing rate ($\text{g cm}^{-2} \text{ hour}^{-1}$ or cm/hour) | I.ir or .iir | 59-62 |
| Probe ID | PP | 63-64 |
| Ice Meter Data (2nd probe, if used) | | |
| LWC (g/m^3) | W.W or .WW | 65-67 |
| Iceing rate ($\text{g cm}^{-2} \text{ hour}^{-1}$ or cm/hour) | I.ir or .iir | 68-71 |
| Probe ID | PP | 72-73 |
| Weather Factors: | | |
| Precip. during measurements (type & intensity) | qt or qq | 74-75 |
| State of cloud particles | ### | 76-79 |
| Card 2 Indicator | 2 | 80 |

TABLE A-2. CODE SYMBOL EXPLANATION

CARD 1 --- COMMON INFORMATION

Mission Identifier (Flight No. or Cloud No.)

Up to 7 symbols are allowed to name or number the flight or cloud.

Date of Measurement

MM = month, DD = day, YY = year

Geographic Location

Use standard 2-letter symbols for states (e.g. KS = Kansas, IL = Illinois), preceded by a regional identifier (w = western, n = northern, s = southern, e = eastern, c = central, o = ocean or shoreline area). For more localized flights use standard 3-letter symbols for the nearest airfield (e.g. BUF = Buffalo, MKG = Muskegon, etc.). For flights localized over or along major lakes, use 2-letter symbols (e.g., LE = Lake Erie, LH = Lake Huron, etc.).

Source of Data: Agency

Use 3 or 4-letter symbols (e.g., NRL, NACA, UWY, MRI, etc.).

Source of Data: Reference

Up to 16 symbols are allowed for report numbers, literature citations.

Altitude Reporting Convention

Scale Used for Data in this Suite

This one letter symbol (P, S, or G) indicates whether the altitudes on this lead card and on the data cards associated with it are all given in terms of pressure altitude (P), altitude above sea level (S), or altitude above the local surface or ground level (G).

Elevation of Local Surface

This information is important for use in later data analyses where altitudes reported variously in pressure altitude, above ground level, etc. must be converted to a common scale. Elevations up to 9900 ft ASL may be reported.

TABLE A-2. CODE SYMBOL EXPLANATION (Continued)

For data from above mountainous terrain where elevation is variable or ambiguous, enter the letter "M" instead of a numerical value.

Cloud Information

Cloud Type

Up to 4 symbols are allowed to describe cloud types. Conventional notation (e.g., St for stratus, Sc for Strato Cumulus, etc.) may be used as well as unconventional notation such as NCSt for non-cyclonic stratus, or CySt for cyclonic status, for example, and OR = orographic, Ln = lenticular.

Cloud Uniformity

C = continuous, I = intermittent (scattered), B = broken, V = variable (Only continuous cloud parcels of about 1 nmi or more in horizontal extent are considered. Cloud parcels separated by short breaks constitute a "broken" cloud, but the cloud parcels selected for use as data are themselves continuous.)

Cloud Base/Top Altitudes

Expressed in hundreds of feet pressure altitude, above ground level or other as specified in column 37 of the first card of the suite.

Airmass Type

Use standard 2 or 3 letter designators such as cP, mPk, etc., or Mm for modified maritime, Mc for modified continental.

Weather Description

Up to 16 symbols are allowed to indicate the relevant weather conditions and the distance and direction of the sampled clouds from a particular feature such as a low pressure center, cold front, etc. (See Table A-3 for one- and two-letter code symbols).

TABLE A-2. CODE SYMBOL EXPLANATION (Continued)

CARD 2 - ICING EVENT DATA

Time of Day for Event

Enter the hour and minute at which the event began. For some of the old NACA data where measurements were conducted over an extended time period, it is necessary to use +h in columns 5-6 to indicate that the measurements occurred for h hours after the indicated starting time. The letter "Z" following an entry indicates Greenwich Mean Time; otherwise, the entry is in local standard time.

Event No.

A 1 or 2 digit number assigned by a data analyst to identify each icing event as a separate entity.

Defining Criterion

Individual icing events are identified and delimited according to the rules for defining uniform cloud intervals given in Table 1 of the text. A code letter is entered in column 9 for icing events defined by one of the level flight criteria, (e.g., "C" indicates that the icing event in question occurred in level flight from the end of the previous event or from the time the aircraft entered the cloud until the outside air temperature rose above 0°C). For vertical profile flights, the code letter "P" specifies that rules for profile data are used to define the icing event in question.

Duration

The time (to the nearest tenth or whole minute) the event lasted. Applies only to events occurring during level flight. For profile flights enter "N" in column 11.

Distance in Cloud

The approximate distance (in nautical miles) traveled by the aircraft during the icing event. Note that the approximate airspeed is required to compute this value. Enter "N" in column 13 for profile flights. Use only for distance flown during actual measurements, not for estimated overall cloud horizontal extent.

TABLE A-2. CODE SYMBOL EXPLANATION (Continued)

Aircraft State during Event

Sampling Maneuver

L = level flight, S = spiral profile, P = slant profile, V = variable

Airspeed

Enter at least an approximate, average, true airspeed (in knots).

Altitude

Expressed in feet pressure altitude, above ground level, or other as specified in column 37 of the first card of the suite, during the event. For use in salvaging NACA data where altitude range extended more than +500 ft, enter 111uu to indicate that altitude was greatly variable between lower (111) and upper (uu) limits expressed in hundreds and thousands of feet, respectively. E.g., data ranging over altitudes from 11,800 to 14,600 ft would be entered as 11815.

Outside Air Temperature

Enter average temperature during event, including the + or - sign and the decimal. To salvage variable altitude (and temperature) NACA data, enter V11uu in columns 23-27 where V indicates a variable altitude case, and 11 and uu are the min and max temperatures (both assumed negative) to the nearest whole degrees Celsius.

LWC Meter Data

This section would normally be used for data obtained from a Johnson-Williams or similar hot wire type of LWC sensor, or from a heated sample dewpoint sensor measurement where no droplet size information is available and an accretion of icing is not necessary for the measurement. Decimal point must be included.

Probe ID

JW = Johnson-Williams, CS = C.S.I.R.O., DP = dewpoint, or others as needed.

Droplet Probe Data

This section is normally used for data from PMS probes, the rotating multicylinders, or other probes which yield droplet or ice particle size information. LWC data is entered as specified above for LWC meters.

TABLE A-2. CODE SYMBOL EXPLANATION (Continued)

MVD (μm)

Enter the indicated median volume diameter (mass median diameter) in microns.

Maximum Droplet Diameter

For the icing cylinder technique this information usually comes from the fixed diameter cylinder covered with sensitized blueprint paper. For droplet counter probes the maximum droplet diameter is defined to be that diameter which includes 95% of all LWC indicated, assuming that the probe(s) in use are sensitive to the largest droplets actually present in the cloud. Rain, drizzle, snow and other frozen particles are not included in this category.

Droplet Number Concentration, N

Enter the indicated number (per cm^3) of droplets in all measured sizes. For the precipitation or large particle probes the entries are in number of particles per liter to the nearest tenth or whole number. For the PMS-ID (OAP) probe, if the concentration exceeds 100 per liter, then use "1c," "2c," etc., to indicate the concentration to the nearest 100, 200, etc., per liter.

Probe ID

A = ASSP, F = FSSP, R = rotating multicylinders, FC = fixed diameter cylinder with sensitized blueprint paper, RF = combination of R and FC. RI = rotating multicylinder data adjusted for exposure for indicated by recording ice rate meters. W = University of Washington (Turner-Radke) Optical Ice Particle Counter.

Ice Meter Data

This section is normally used for data from ice accretion sensors without droplet size information. LWC, if deducible from the probe, is entered as specified above for LWC meters.

Icing Rate

This information is not often included in the data reports but it is a desirable piece of information. Enter the rate to the nearest tenth, accuracy permitting. Following the numerical entry, enter the letter "C" if rate is in $\text{g cm}^{-2}/\text{hour}$, or "I" if rate is in $\text{inches}/\text{hour}$.

TABLE A-2. CODE SYMBOL EXPLANATION (Continued)

Probe ID

RO = Rosemount model 871, 10 = Leigh (Mark 10), 12 = Leigh (Mark 12), RM = rotating multicylinders, RD = rotating disk, PA = probe based on pressure sensitive array of holes.

Weather Factors

Precipitation During Measurements

This item refers to the occurrence of precipitation in or from the cloud, preferably as observed from the aircraft. Observations from the ground are allowable only if precipitation is observed. Absence of precipitation at the ground is no indicator that precipitation is lacking in, or just below the cloud, since the precipitation may be evaporating before it reaches the ground. Conventional reporting symbols are to be used, such as S- = light snow, S = moderate snow, S+ = heavy snow, etc.

State of Cloud Particles

Columns 76-79 may be used for qualitative observations on the state (liquid or frozen) of the cloud. Symbols may be mS = mostly snow, mW = mostly water, mI = mostly ice, mW+I = mostly water with some ice, etc.

General Information

For all cases, enter the letter "U" when the value for an entry is unknown. If the entry category does not apply, e.g., columns 10-11 and 12-13 for profile flights, enter "N" for not applicable. An asterisk (*) preceding an entry denotes an estimated entry. The letter "X" indicates that a value was supplied for the entry but that it was obviously an incorrect value due to miscalculation or to instrument mal-performance. The lower case letter "m" indicates a missing value, usually because the required computations or averages have not yet been performed even though the data are available to the analyst.

TABLE A-3. LIST OF CODE SYMBOLS
(Use separately or in combination)

A = Ahead of
Bt = Between
C = Convergence
Cf = Cold front
Cl = Cloud(s)
Cv = Convection
Cy = Cyclone, cyclonic flow
D = Dense
Dy = Dry
d = Due to
E = East
Ey = Easterly
F = Following
Fl = Flight level
Fm = Fast moving
Fw = Fair weather
g = General(ly)
Hc = High pressure center
Hp = High pressure region
I = Inversion
Inn = Inversion at flight level nn
L = Layer
Lc = Low pressure center
Lp = Low pressure region
La = Lake effect
M = Moderate, medium
N = North
Ny = Northerly
O = Over
Oc = Occluded
Of = Occluded front
Or = Orographic
Ot = Outside of
P = Precipitation
Pg = Pressure gradient
P = Possibly, possible
R = Ridge
Rb = Rainband
S = South
Sf = Stationary front
Sm = Slow moving
Sr = Strong, deep
St = Stationary
Su = Surface
Sy = Southerly
s = Some
T = Thin
Tb = Turbulence
Tr = Trough
Ua = Unstable air

Ud = Updraft
Uf = Upslope flow
Up = Upper, upper level, upper part
u = Usually
W = West
Wf = Warm front
Wi = Wind(s)
Wk = Weak
Wv = Wave
Wy = Westerly
* = Estimated value follows
→ = To, moving toward
? = Amount or type uncertain
.5, 1, 2, ... = Numeral indicating distance in hundreds of nmi

PRECIPITATION CODE SYMBOLS

R = Rain
S = Snow
ZR = Freezing Rain
L = Drizzle
ZL = Freezing Drizzle
E = Sleet
A = Hail
SP = Snow Pellets
T = Thunderstorm

CLOUD NAMES

St = Stratus
Sc = Stratocumulus
Ns = Nimbostratus
As = Altostratus
Ac = Altocumulus
Cu = Cumulus
Cb = Cumulonimbus

TABLE A-3. LIST OF CODE SYMBOLS (Continued)

LOCATION IDENTIFIER CODE

| Symbol | Location | Symbol | Location |
|--------|--------------------------|--------|--------------------------|
| AZ | Arizona | LAN | Lansing, MI |
| AKO | Akron, CO | LBF | North Platte, NE |
| AOO | Altoona, PA | LTA | Lake Tahoe, CA |
| AST | Astoria, OR | LHX | La Junta, CO |
| BLU | Blue Canyon, CA | MA | Massachusetts |
| CA | California | MD | Maryland |
| CO | Colorado | ME | Maine |
| CAK | Akron, OH | MI | Michigan |
| CDR | Chadron, NE | MN | Minnesota |
| CLE | Cleveland, OH | MO | Missouri |
| CYS | Cheyenne, WY | MT | Montana |
| DDC | Dodge City, KS | MCC | McClellan AFB, CA |
| DEN | Denver, CO | MCK | McCook, NE |
| DET | Detroit, MI | MEM | Memphis, TN |
| DHT | Dalhart, TX | MFD | Manfield, OH |
| DLH | Duluth, MN | MFR | Medford, OR |
| EAU | Eau Claire, WI | MKG | Muskegon, MI |
| FLC | Flagstaff, AZ | MRY | Monterey, CA |
| GCK | Garden City, KS | MSP | Minneapolis-St. Paul, MN |
| GLD | Goodland, KS | NC | North Carolina |
| GLL | Greeley, CO | NE, NB | Nebraska |
| GSH | Goshen, IN | NJ | New Jersey |
| HGR | Hagerstown, MD | NM | New Mexico |
| HQM | Hoquiam, WA | NV | Nevada |
| HTS | Huntington, WV | NY | New York |
| IA | Iowa | OH | Ohio |
| ID | Idaho | OR | Oregon |
| IL | Illinois | OLM | Olympia, WA |
| IN | Indiana | OMA | Omaha, NE |
| IAD | Dulles Int'l Airport, VA | ORF | Norfolk, VA |
| JST | Johnstown, PA | PA | Pennsylvania |
| KS | Kansas | PAE | Everett Paine Field, WA |
| LA | Louisiana | PDX | Portland, OR |
| LE | Lake Erie | PIH | Pocatello, ID |
| LH | Lake Huron | QUE | Quebec, Canada |
| LM | Lake Michigan | RDD | Redding, CA |
| LS | Lake Superior | ROA | Roanoke, VA |
| | | RWL | Rawlins, WY |

TABLE A-3. LIST OF CODE SYMBOLS (Continued)

LOCATION IDENTIFIER CODE

| Symbol | Location | Symbol | Location |
|--------|-------------------|--------|-------------------|
| SP | Spain | VA | Virginia |
| SCQ | Santiago, Spain | VLL | Valladolid, Spain |
| SEA | Seattle, WA | VWV | Waterville, OH |
| SMF | Sacramento, CA | | |
| SNY | Sidney, NE | WA | Washington |
| SYR | Syracuse, NY | WI | Wisconsin |
| | | WV | West Virginia |
| TN | Tennessee | WY | Wyoming |
| TX | Texas | W72 | (offshore, VA,NC) |
| TVC | Traverse City, MI | | |
| | | 237 | (offshore, WA) |
| UT | Utah | | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE
Data File No. 1

| Card Column No. | | | | | |
|---|----------------------------|-------------|--------|---|---------------|
| 11111111112222222222333333333344444444445555555555666666666677777777778 12345678901234567890123456789012345678901234567890123456789012345678901234567890 | | | | | |
| Rec. No. | Card (Record) Contents | | | | |
| 1 F26 | 032146wNVNACANACA TN-1393 | P40Ac | BU | U | WcPwkl p |
| 2 1600+16 H | 717L13910650 -8.6 N | N .3814U | R | Z | N N N SWmW |
| 3 1700-16H | 1 2L13910650 -8.6N | N .7 U | U | U | N N N SWmW |
| 4 F27A | 032246uORNACA NACA TN-1393 | PU Cu | BU | U | MmPMO-3FFmCf |
| 5 14130+ | 7H 2 4L1398650 -12.5N | N .3617U | U | R | N N N N W |
| 6 14145- | 7H 1 2L1398650 -12.5N | N .7 U | U | U | N N N R N W |
| 7 F27B | 032246uORNACA NACA TN-1393 | PU Sc | BU | U | MmPMO-3FFmCf |
| 8 1515+ | 8H 3 7L1396900 -9.3N | N .06U | U | U | N N N S mS |
| 9 1515- | 8H 1 2L1396900 -9.3N | N .2 U | U | U | N N N S mS |
| 10 F28A | 032446cURNACA NACA TN-1393 | P40CuCBBU | U | U | MmPM3AHc |
| 11 1115+ | 9H 512V139 6678V0811N | N .4814U | U | R | N N N U mW |
| 12 12100- | 9H 1 2V139 6678V0811N | N .8 U | U | R | N N N U mW |
| 13 F28B | 032446uDNACA NACA TN-1393 | PU CuCBBU | U | U | MmPJ-5FFmCf |
| 14 12155 | 10H 3 7L13910900 -16.4N | N .2 16U | U | R | N N N S WS |
| 15 F28C | 032446uDNACA NACA TN-1393 | PU Cb | IU | U | MmPJ-5FFmCf |
| 16 15130 | 11H 3 7L13913200 -21. N | N .4 U | U | U | N N N S WS |
| 17 F30 | 032746eURNACA NACA TN-1393 | P40AmAcCU | U | U | MmPOSmCf |
| 18 16100 | 13H1 2 V139 8012V0309N | N .0508U | U | R | N N N S mS |
| 19 F31A | 032946oURNACA NACA TN-1393 | P40Cu UU | U | U | MmP4FSmCf |
| 20 1030+114H | 614V139 7190V0913N | N .6114U | U | R | N N N U mW |
| 21 1130-114H1 | 2 V139 7190V0913N | N .9 U | U | R | N N N U mW |
| 22 F31B | 032946uDNACA NACA TN-1393 | PU CbAUU | U | U | MmPM1-2F5mCf |
| 23 1550+215H | 3 7V139 9013V1019N | N .1811U | U | R | N N N S mS |
| 24 1800-215H1 | 2 V139 9013V1019N | N .5 U | U | R | N N N S mS |
| 25 F32A | 033046uDNACA NACA TN-1393 | PU Cb UU | U | U | MmPMO-1ASmCf |
| 26 11103 | 16H1 2 L13912500 -9.4 N | N .6 28U | U | R | N N N U mW |
| 27 F32B | 033046cCANACA NACA TN-1393 | PM Cb UU | U | U | MmPMO-2F5mCf |
| 28 13117 | 17H1 2 L13911100 -13.9N | N .J 45U | U | R | N N N S mS |
| 29 F32C | 033046cCANACA NACA TN-1393 | PU CuCBBU | U | U | mP M1-2F5mCf |
| 30 1340+118H | 512V139 /898V0711N | N .6413U | U | R | N N N U mW |
| 31 1430-118H1 | 2 V139 /898V0711N | N .9 U | U | R | N N N U mW |
| 32 F33 | 033146cCANACA NACA TN-1393 | P0 CuCbVU | U | U | mP WkHp |
| 33 1100+319H1 | 125V139 5712V0214N | N .4411U | U | R | N N N S WS |
| 34 1345-319H1 | 2 V139 5712V0214N | N 1.0U | U | R | N N N S WS |
| 35 F34 | 040146cCANACA NACA TN-1393 | P 00CuCb142 | +1.5 U | U | mP WkPg 1n Hp |
| 36 1510+220H | 512V139 6310V0312 N | N .5313 U | U | R | N N N S WS |
| 37 1640-220H | 1 2V139 6310V0312 N | N .8 U | U | R | N N N S WS |
| 38 F35 | 040346cCANACA NACA TN-1393 | P MAc C | U | U | mP WkPg 1n Hp |
| 39 16122+21H | 3 7V139 9112V0913 N | N .1313 U | U | R | N N N S WS |
| 40 16147-21H | 1 2V139 9112V0913 N | N .3 U | U | R | N N N S WS |
| 41 F36 | 040546wURNACA NACA TN-1393 | P 0515cc | U | U | mP MO-2FWxCf |
| 42 17125+22H | 4 9L139 4750 -3.6 N | N .4812 U | U | R | N N N U W |
| 43 17157-22H | 1 2L139 4750 -3.6 N | N .7 U | U | R | N N N U W |
| 44 F37 | 040646wURNACA NACA TN-1393 | P 05c BU | U | U | mP Hp |
| 45 1243+123H4 | 9 V139 4658V0407 N | N .2213 U | U | R | N N N N U U |
| 46 1330-123H | 1 2V139 4658V0407 N | N .4 13 U | U | R | N N N N U W |
| 47 F38A | 040746wNVNACA NACA TN-1393 | P UCu I | U | U | MmPWkLP,OPg |
| 48 1200+524H9 | 21V13911815V0816 N | N .6117 U | U | R | N N N N U mW |
| 49 1650-524H | 1 2V13911815V0816 N | N 1.1 U | U | R | N N N N U mW |
| 50 F38B | 040746sWYNACA NACA TN-1393 | P MCbR=I | U | U | cP OPgM3FFmCf |
| 51 1200+525H1023V139 | 11815V0816 N | N .1112 U | U | R | N N N S mS |
| 52 1650-525H | 1 2V13911815V0816 N | N .2 U | U | R | N N N S mS |
| 53 F39 | 040846CYSNACANACA TN-1393 | P50b16cc | | | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)

[illegible]

TABLE A-4. THE NEW SUPERNOVEL CLUSTER DATA BASE (Continued)
Data File No. 3

[illegible]

Data File No. 9

111111111122222222223333333333444444444455555555556666666666777777777788888888889999999999
123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890

TABLE A-4. THE NEW SUPERNOVED CLOUD DATA BASE (Continued)
Data File No. 5

| Card Column No. | | Card (Record) Contents | | Card Column No. | | Card (Record) Contents | |
|---|--------|--------------------------------|-----------|--|-----|------------------------|------------|
| 11111111112222222222333333333344444444445555555555666666666677777777778 | | | | 1234567890123456789012345678901234567890123456789012345678901234567890 | | | |
| Rec. No. | | | | | | | |
| 1 | F38 | 0226470LE NACA NACA IN-1424 | P 7 5a U | U | U | U | U |
| 2 | 1200+2 | H 1 3L181 6500-15.0 | N N .1215 | U U R | N N | NN NN | 1.31RD N N |
| 3 | | H 1 3L181 6500-15.0 | N N .1136 | U U R | N N | NN NN | 1.31RD N N |
| 4 | 1400-2 | H 1 3L181 6500-15.0 | N N .1401 | U U R | N N | NN NN | 1.31RD N N |
| 5 | F40 | 0303470LE NACA NACA IN-1424 | P 7 5a U | U | U | U | U |
| 6 | 1200+3 | H 1 3L168 5750-16.7 | N N .0612 | U U R | N N | NN NN | 1.31RD N N |
| 7 | F41 | 030547 LE NACA NACA IN-1424 | P 6 5a U | U | U | U | U |
| 8 | 1420+1 | H 1 3L166 3370-10.0 | N N .22 8 | U U R | N N | NN NN | 1.31RD N N |
| 9 | F24 | 070647RUA NACA NACA IN-1424 | P M A U | U | U | U | U |
| 10 | 1220+1 | H 2 6L194 9810 -7.2 | N N .2718 | U U R | N N | NN NN | 2.71RD N N |
| 11 | 1330-1 | H 2 6L176 9910 -6.7 | N N .1418 | U U R | N N | NN NN | 2.71RD N N |
| 12 | F44 | 0313470LE NACA NACA IN-1424 | P 7 A U | U | U | U | U |
| 13 | 1500+3 | H 1 3L171 11040 -6.1 | N N .1824 | U U R | N N | NN NN | 2.31RD N N |
| 14 | F27 | 031447 LE NACA NACA IN-1424 | P 6 5a U | U | U | U | U |
| 15 | 1300+1 | H 1 3L155 5600 -6.7 | N N .3415 | U U R | N N | NN NN | 2.21RD N N |
| 16 | | H 1 3L158 5375 -6.1 | N N .1513 | U U R | N N | NN NN | 2.91RD N N |
| 17 | 1430-1 | H 1 3L161 5480 -6.1 | N N .1814 | U U R | N N | NN NN | 1.71RD N N |
| 18 | F49 | 040747 LE NACA NACA IN-1424 | P 6 5a U | U | U | U | U |
| 19 | 1030+2 | H 1 3L157 4300 -7.2 | N N .3025 | U U R | N N | NN NN | 4.01RD N N |
| 20 | | H 1 3L164 4300 -7.2 | N N .4215 | U U R | N N | NN NN | 3.61RD N N |
| 21 | | H 1 3L157 4300 -7.2 | N N .1311 | U U R | N N | NN NN | 1.41RD N N |
| 22 | 1230-2 | H 1 3L161 4300 -7.2 | N N .2116 | U U R | N N | NN NN | 1.41RD N N |
| 23 | B-24M1 | 121147LE NACA NACA IN-1793 | P 6 5a U | U | U | U | U |
| 24 | 12130 | 1H 1 3L151 5560-11.7 | N N .2813 | U U R | N N | NN NN | U U U U |
| 25 | 12140 | 2H 1 3L178 6170-12.8 | N N .10 9 | U U R | N N | NN NN | U U U U |
| 26 | 12151 | 3H 1 3L166 5640-11.7 | N N .0810 | U U R | N N | NN NN | U U U U |
| 27 | B-24M2 | 0102480LE NACA NACA IN-1793 | P 7 5a U | U | U | U | U |
| 28 | 15130 | 1H 1 3L148 3600 -6.1 | N N .57 0 | U U R | N N | NN NN | U U U U |
| 29 | 15130 | 2H 1 3L148 3600 -6.1 | N N .32 8 | U U R | N N | NN NN | U U U U |
| 30 | B-25E | 030303480WYN NACA NACA IN-1793 | P 6 5a U | U | U | U | U |
| 31 | 12114 | 1H 1 3L175 3650-11.7 | N N .2411 | U U R | N N | NN NN | U U U U |
| 32 | 12121 | 2H 1 3L166 3650-11.7 | N N .40 9 | U U R | N N | NN NN | U U U U |
| 33 | 12133 | 3H 1 3L160 3090-10.0 | N N .1511 | U U R | N N | NN NN | U U U U |
| 34 | 12140 | 4H 1 3L178 3150-10.6 | N N .0810 | U U R | N N | NN NN | U U U U |
| 35 | 13109 | 5H 1 3L176 3620-09.4 | N N .1512 | U U R | N N | NN NN | U U U U |
| 36 | 13116 | 6H 1 3L175 3620-10.6 | N N .2110 | U U R | N N | NN NN | U U U U |
| 37 | 13128 | 7H 1 3L173 3150-11.7 | N N .10 9 | U U R | N N | NN NN | U U U U |
| 38 | B-24M4 | 0303480LE NACA NACA IN-1793 | P 7 5a U | U | U | U | U |
| 39 | 10136 | 1H 1 3L154 3740 -7.2 | N N .3114 | U U R | N N | NN NN | U U U U |
| 40 | 10145 | 2H 1 3L151 3690 -5.6 | N N .3813 | U U R | N N | NN NN | U U U U |
| 41 | 10153 | 3H 1 3L153 3540 -6.1 | N N .1918 | U U R | N N | NN NN | U U U U |
| 42 | 11104 | 4H 1 3L159 3620 -5.0 | N N .1421 | U U R | N N | NN NN | U U U U |
| 43 | 11114 | 5H 1 3L168 3090 -5.6 | N N .1620 | U U R | N N | NN NN | U U U U |
| 44 | 11125 | 6H 1 3L154 3800 -4.4 | N N .1822 | U U R | N N | NN NN | U U U U |
| 45 | B-24M5 | 0104480PANACA NACA IN-1793 | P M 5a U | U | U | U | U |
| 46 | 12105 | 1H 1 3L165 2920 -5.6 | N N .1015 | U U R | N N | NN NN | U U U U |
| 47 | B-24M6 | 0316480FINACA NACA IN-1793 | P 6 5a U | U | U | U | U |
| 48 | 15108 | 1H 1 3P172 6080 -3.3 | N N .1820 | U U R | N N | NN NN | U U U U |
| 49 | 15120 | 2H 1 3P175 6130 -3.9 | N N .2115 | U U R | N N | NN NN | U U U U |
| 50 | 15132 | 3H 1 3P176 7300 -5.0 | N N .2317 | U U R | N N | NN NN | U U U U |
| 51 | B-24M7 | 0323480MINACA NACA IN-1793 | P 3 5a U | U | U | U | U |
| 52 | 18120 | 1H 1 3L172 8900 -6.1 | N N .1515 | U U R | N N | NN NN | U U U U |
| 53 | 18132 | 2H 1 3L177 8100 -6.7 | N N .1720 | U U R | N N | NN NN | U U U U |
| 54 | 18144 | 3H 1 3L172 8710 -7.8 | N N .1322 | U U R | N N | NN NN | U U U U |
| 55 | 18153 | 4H 1 3L176 8250 -8.3 | N N .1021 | U U R | N N | NN NN | U U U U |
| 56 | 19100 | 5H 1 3L173 9110 -8.9 | N N .2211 | U U R | N N | NN NN | U U U U |
| 57 | 19113 | 6H 1 3L164 9210 -9.4 | N N .1215 | U U R | N N | NN NN | U U U U |
| 58 | 19116 | 7H 1 3L176 9850 -8.9 | N N .08 7 | U U R | N N | NN NN | U U U U |
| 11111111112222222222333333333344444444445555555555666666666677777777778 | | | | 1234567890123456789012345678901234567890123456789012345678901234567890 | | | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)

| Rec. No. | | Card (Record) Contents | | Card Column No. | | 11111111112222222222333333333344444444445555555555666666666677777777778 | | 1234567890123456789012345678901234567890123456789012345678901234567890 | |
|----------|--------|------------------------|----------------------|-----------------|--------|---|-----|--|---|
| 1 | B-24MB | 033048 | GUENACA NACA TN-1793 | P | 6CuScU | U | UcP | Hp | 1 |
| 2 | 10:01 | 1H 1 | 3L171 6990-10.0 | N | N | .1910 | U | U | U |
| 3 | B-24M9 | 040148 | ELMNACA NACA TN-1793 | P | 6ScU | U | Uc | Le2-4N5rLc | 1 |
| 4 | 08:41 | 1H 1 | 3P160 7190 -5.8 | N | N | .13 | U | U | U |
| 5 | 09:04 | 2H 1 | 3P165 5880 -3.9 | N | N | .47 | 8 | U | U |
| 6 | 09:09 | 3H 1 | 3P165 5720 -4.4 | N | N | .20 | 8 | U | U |
| 7 | 09:16 | 4H 1 | 3P164 6740 -6.7 | N | N | .0810 | U | U | U |
| 8 | 09:25 | 5H 1 | 3P172 5070 -5.0 | N | N | .39 | 9 | U | U |
| 9 | 09:33 | 6H 1 | 3P165 5170 -3.9 | N | N | .4812 | U | U | U |
| 10 | 09:40 | 7H 1 | 3P158 4870 -3.9 | N | N | .4412 | U | U | U |
| 11 | 09:53 | 8H 1 | 3P166 4830 -3.3 | N | N | .3811 | U | U | U |
| 12 | 10:00 | 9H 1 | 3P158 5120 -3.3 | N | N | .3212 | U | U | U |
| 13 | 10:07 | 10H 1 | 3P122 4470 -4.4 | N | N | .2812 | U | U | U |
| 14 | 10:14 | 11H 1 | 3P150 3890 -3.9 | N | N | .46 | 5 | U | U |
| 15 | 10:35 | 12H 1 | 3P173 7290 -8.9 | N | N | .1616 | U | U | U |
| 16 | 151 | 020448 | CANACA NACA TN-1904 | P | MCu | U | U | U | U |
| 17 | 16:47 | 1H 3 | 8L16213500-21.7 | N | N | .0747 | U | U | U |
| 18 | 17:00 | 2H 3 | 8L155 7400 -8.3 | N | N | .3322 | U | U | U |
| 19 | 17:05 | 3H 4 | 9L135 5900 -6.1 | N | N | .2317 | U | U | U |
| 20 | 17:25 | 4H 1 | 2L137 8900-12.2 | N | N | .4132 | U | U | U |
| 21 | 17:29 | 5H 1 | 2L14010400-15.6 | N | N | .2426 | U | U | U |
| 22 | 152 | 020648 | CANACA NACA TN-1904 | P | MCu | U | U | U | U |
| 23 | 15:14 | 1H 2 | 5L15211200-17.2 | N | N | .361832 | N | R | N |
| 24 | 15:46 | 2H 3 | 8L159 7000 -9.3 | N | N | .411820 | N | R | N |
| 25 | 15:50 | 3H 3 | 7L145 7100 -9.3 | N | N | .231919 | N | R | N |
| 26 | 15:53 | 4H 1 | 2L139 7000 -9.3 | N | N | .402026 | N | R | N |
| 27 | 16:07 | 5H 1 | 2L130 8200-10.6 | N | N | .972228 | N | R | N |
| 28 | 16:13 | 6H 2 | 4L126 9300-13.3 | N | N | .6327 | U | N | R |
| 29 | 153 | 020748 | WMANACA NACA TN-1904 | P | UAe | U | U | U | U |
| 30 | 16:31 | 1H 3 | 9L175 6900 -6.1 | N | N | .1150 | U | N | R |
| 31 | 16:38 | 2H 3 | 8L160 6900 -6.7 | N | N | .0550 | U | N | R |
| 32 | 154 | 020848 | WMANACA NACA TN-1904 | P | UAe | U | U | U | U |
| 33 | 14:15 | 1H 3 | 8L155 9300-12.2 | N | N | .102225 | N | R | N |
| 34 | 14:19 | 2H 3 | 8L166 9300-12.2 | N | N | .022322 | N | R | N |
| 35 | 14:55 | 3H 3 | 9L17612300-18.9 | N | N | .040809 | N | R | N |
| 36 | 154A | 020848 | WMANACA NACA TN-1904 | P | UCuCuU | U | U | U | U |
| 37 | 15:35 | 1H 3 | 8L153 7000 -9.4 | N | N | .011215 | N | R | N |
| 38 | 15:56 | 2H 1 | 3L157 8300-13.9 | N | N | .522550 | N | R | N |
| 39 | 16:17 | 3H 1 | 2L144 4700 -6.1 | N | N | .3823 | U | N | R |
| 40 | 155 | 020948 | WMANACA NACA TN-1904 | | | | | | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)

| Rec. No. | | Card (Record) | | Contents | | Card Column No. | | 11111111112222222222333333333344444444445555555555666666666677777777778 | | 1234567890123456789012345678901234567890123456789012345678901234567890 | |
|----------|-------|---------------|-----------------------|----------|--------|-----------------|-------|---|-----------|--|---|
| 1 | 159 | 021348 | ILNACA NACA TN-1904 | P 6 | StNUU | U | U | c | Lp+P | U | 1 |
| 2 | 11.59 | 1H 3 | 7L1422000 | -2.8 | N N N | .082050 | N R | N | N | U | 2 |
| 3 | 12.04 | 2H 3 | 7L1402000 | -3.3 | N N N | .091850 | N R | N | N | U | 2 |
| 4 | 12.32 | 3H 2 | 4L1241300 | -3.9 | N N N | .015050 | N R | N | N | U | 2 |
| 5 | 12.39 | 4H 3 | 7L1362500 | -6.7 | N N N | .040914 | N R | N | N | U | 2 |
| 6 | 166 | 030848 | CANACA NACA TN-1904 | P | MCUCBU | U | U | mP | WkHp? | U | 2 |
| 7 | 17.55 | 1H 1 | 2L14512400 | -11.7 | N N N | .473344 | N R | N | N | U | 2 |
| 8 | 18.00 | 2H 2 | 5L15111600 | -11.7 | N N N | .3150 | U N R | N | N | U | 2 |
| 9 | 18.07 | 3H 1 | 2L14710800 | -10.0 | N N N | .1419 | U N R | N | N | U | 2 |
| 10 | 18.11 | 4H 1 | 2L13611400 | -11.1 | N N N | .4756 | U N R | N | N | U | 2 |
| 11 | 18.14 | 5H 1 | 3L16611200 | -10.0 | N N N | .5444 | U N R | N | N | U | 2 |
| 12 | 18.16 | 6H 1 | 3L16511200 | -11.1 | N N N | .20 | U U N | R | N | U | 2 |
| 13 | 167 | 030948 | ANAZNACA NACA TN-1904 | P | MCBCUU | U | U | MmPCy+Lp | #25Lc | U | 1 |
| 14 | 14.07 | 1H 1 | 3L18714600 | -19.4 | N N N | .311919 | N R | N | N | U | 2 |
| 15 | 14.10 | 2H 1 | 3L17214200 | -18.9 | N N N | .261923 | N R | N | N | U | 2 |
| 16 | 14.13 | 13H 1 | 3L15814500 | -20.0 | N N N | .2921 | U N R | N | N | U | 2 |
| 17 | 14.16 | 4H 1 | 3L17114400 | -20.0 | N N N | .22 | 9 U N | R | N | U | 2 |
| 18 | 14.19 | 5H 2 | 5L15414700 | -20.6 | N N N | .2022 | U N R | N | N | U | 2 |
| 19 | 14.55 | 6H 1 | 3L16014700 | -20.0 | N N N | .381720 | N R | N | N | U | 2 |
| 20 | 15.09 | 7H 1 | 2L14914400 | -18.9 | N N N | .392021 | N R | N | N | U | 2 |
| 21 | 15.22 | 8H 1 | 2L14014700 | -20.0 | N N N | .1228 | U N R | N | N | U | 2 |
| 22 | 16.49 | 9H 2 | 5L16014500 | -15.0 | N N N | .3620 | U N R | N | N | U | 2 |
| 23 | 17.00 | 10H 1 | 3L16613400 | -12.8 | N N N | .5917 | U N R | N | N | U | 2 |
| 24 | 170 | 031248 | WORNACA NACA TN-1904 | P | 0AcAaU | U | U | mP | #1-35WkLc | U | 1 |
| 25 | 13.30 | 1H 2 | 5L15310000 | -9.4 | N N N | .0918 | U N R | N | N | U | 2 |
| 26 | 13.33 | 2H 3 | 7L14610100 | -9.4 | N N N | .2233 | U N R | N | N | U | 2 |
| 27 | 13.45 | 3H 4 | 11L17310000 | -9.4 | N N N | .131448 | N R | N | N | U | 2 |
| 28 | 13.53 | 4H 2 | 5L16210200 | -10.0 | N N N | .151416 | N R | N | N | U | 2 |
| 29 | 13.56 | 5H 3 | 8L15910300 | -10.6 | N N N | .181616 | N R | N | N | U | 2 |
| 30 | 14.06 | 6H 4 | 11L16610200 | -10.0 | N N N | .1523 | U N R | N | N | U | 2 |
| 31 | 14.20 | 7H 5 | 14L1679900 | -10.6 | N N N | .091043 | N R | N | N | U | 2 |
| 32 | 14.26 | 8H 3 | 9L17110100 | -10.0 | N N N | .101543 | N R | N | N | U | 2 |
| 33 | 14.34 | 9H 3 | 8L16310150 | -10.0 | N N N | .131634 | N R | N | N | U | 2 |
| 34 | 170A | 031248 | 6ORNACA NACA TN-1904 | P | 0Sc | U | U | mP | #1-35 | | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 8

| Rec. No. | | Card (Record) Contents | | Card Column No. | |
|----------|-------|------------------------|---------------------|-----------------|----------------|
| 1 | 174 | 031948c | CANACA NACA TN-1904 | P MCu | UU |
| 2 | 14.02 | 1H 3 | 8L16211400-16.7 | N N | .8912 U N RI N |
| 3 | 14.08 | 2H 2 | 4L12711500-16.7 | N N | 1.21117 N RI N |
| 4 | 14.15 | 3H 2 | 5L15512200-18.9 | N N | .920911 N RI N |
| 5 | 175A | 032248c | CANACA NACA TN-1904 | P OAa | AcUU |
| 6 | 12.32 | 1H 4 | 12L17913000 -7.8 | N N | .1423 U N RI N |
| 7 | 13.58 | 2H 2 | 5L1557900 -7.8 | N N | .0724 U N RI N |
| 8 | 175 | 032248c | ORNACA NACA TN-1904 | P OCb | CuUU |
| 9 | 14.09 | 1H 1 | 2L1486700 -6.7 | N N | .174547 N RI N |
| 10 | 14.14 | 2H 1 | 3L1567300 -8.3 | N N | .272437 N RI N |
| 11 | 14.19 | 3H 1 | 3L1596000 -7.8 | N N | .282025 N RI N |
| 12 | 14.23 | 4H 2 | 5L1458700 -8.3 | N N | .232537 N RI N |
| 13 | 14.39 | 5H 4 | 11L1728800 -11.7 | N N | .242534 N RI N |
| 14 | 14.55 | 6H 1 | 3L1628000 -10.6 | N N | .692022 N RI N |
| 15 | 15.05 | 7H 3 | 7L1498900 -11.7 | N N | .562023 N RI N |
| 16 | 15.11 | 8H 1 | 3L1569200 -12.8 | N N | .6822 U N RI N |
| 17 | 15.14 | 9H 2 | 5L1379700 -13.3 | N N | .262323 N RI N |
| 18 | 15.19 | 10H 2 | 5L1629900 -14.4 | N N | .9532 U N RI N |
| 19 | 15.27 | 11H 4 | 10L1559800 -15.6 | N N | .4628 U N RI N |
| 20 | 15.34 | 12H 1 | 3L16110300 -16.7 | N N | .6331 U N RI N |
| 21 | 176 | 032348M | FRNACA NACA TN-1904 | P13C | uCbUU |
| 22 | 14.02 | 1H 2 | 5L165 9900-10.6 | N N | .371318 N RI N |
| 23 | 14.08 | 2H 4 | 11L169 8800 -9.4 | N N | .2916 U N RI N |
| 24 | 14.15 | 3H 3 | 8L15211500-12.2 | N N | .5425 U N RI N |
| 25 | 14.21 | 4H 1 | 2L14011900-11.7 | N N | .5327 U N RI N |
| 26 | 16.24 | 5H 3 | 7L14911600-10.6 | N N | .332729 N RI N |
| 27 | 16.55 | 6H 2 | 5L14410200-10.0 | N N | .6828 U N RI N |
| 28 | 17.03 | 7H 2 | 5L148 9800 -7.7 | N N | .3726 U N RI N |
| 29 | 177 | 032448c | CANACA NACA TN-1904 | P OCu | CbUU |
| 30 | 13.29 | 1H 3 | 8L15113000-19.4 | N N | 1.050 U N RI N |
| 31 | 14.51 | 2H 1 | 3L157 8800 -9.4 | N N | .282645 N RI N |
| 32 | 14.58 | 3H 1 | 3L160 9100 -8.3 | N N | .582745 N RI N |
| 33 | 15.05 | 4H 1 | 3L163 9300 -8.8 | N N | .432943 N RI N |
| 34 | 179 | 032948c | CANACA NACA TN-1904 | P OCu | CbUU |
| 35 | 12.03 | 1H 1 | 3L17013700-13.9 | N N | .782327 N RI N |
| 36 | 12.17 | 2H 1 | 3L19513700-14.4 | N N | .2628 U N RI N |
| 37 | 12.25 | 3H 3 | 9L18411800-10.6 | N N | .7423 U N RI N |
| 38 | 12.32 | 4H 1 | 3L16811700-10.0 | N N | .642324 N RI N |
| 39 | 12.39 | 5H 2 | 5L15812100-10.6 | N N | .9824 U N RI N |
| 40 | 12.44 | 6H 1 | 3L15211750-11.1 | N N | .6118 U N RI N |
| 41 | 12.48 | 7H 1 | 3L16211500-10.6 | N N | .6132 U N RI N |
| 42 | 12.57 | 8H 2 | 5L14011400-10.0 | N N | .9825 U N RI N |
| 43 | 13.02 | 9H 2 | 5L15810400 -8.9 | N N | .8823 U N RI N |
| 44 | 13.15 | 10H 1 | 3L15711600-10.6 | N N | .842022 N RI N |
| 45 | 13.29 | 11H 1 | 3L15413600-15.0 | N N | .40 U U N RI N |
| 46 | 13.33 | 12H 1 | 3L18714800-15.0 | N N | .462326 N RI N |
| 47 | 14.00 | 13H 1 | 3L17014500-14.4 | N N | 1.714 U N RI N |
| 48 | 14.26 | 14H 1 | 3L17214600-14.4 | N N | 1.219 U N RI N |
| 49 | 14.28 | 15H 1 | 3L17913700-12.2 | N N | .9425 U N RI N |
| 50 | 15.47 | 16H 2 | 5L16311800 -9.4 | N N | 1.12528 N RI N |
| 51 | 181 | 040248R | DDNACA NACA TN-1904 | P MACa | AMU |
| 52 | 15.10 | 1H 3 | 9L17213100-12.2 | N N | .182228 N RI N |
| 53 | 15.15 | 2H 5 | | | |

TABLE A 4. THE NEW SUPERDOLORED CLOUD DATA BASE (Continued)
Data file No. 9

| Rec. No. | | Card (Record) | | Contents | | Card Column No. | |
|----------|-------|---------------|----------|-------------|---------|-----------------|-------------|
| 1 | 183A | 040548 | SEANACA | NACA | TN-1904 | P 0Ac | U U U |
| 2 | 15.59 | 1H | 3 6L179 | 7900-11.1 | N N | .2837 | U N K I N N |
| 3 | 16.10 | 2H | 3 8L157 | 7900-11.1 | N N | .2447 | U N R I N N |
| 4 | 16.18 | 3H | 410L161 | 8000-11.1 | N N | .101722 | N R I N N |
| 5 | 16.29 | 4H | 514L162 | 8000-10.0 | N N | .1923 | U N R I N N |
| 6 | 16.35 | 5H | 2 5L156 | 8000-12.2 | N N | .2818 | U N K I N N |
| 7 | 16.41 | 5H | 513L160 | 8100-12.2 | N N | .172122 | N K I N N |
| 8 | 17.26 | 7H | 514L166 | 8100-10.6 | N N | .1321 | U N R I N N |
| 9 | 15.14 | 8H | 2 6L1681 | 4650-25.0 | N N | .0320 | U N K I N N |
| 10 | 15.21 | 9H | 1 3L192 | 9500-14.4 | N N | .1946 | U N K I N N |
| 11 | 15.33 | 10H | 1 3L172 | 9000-12.8 | N N | .1850 | U N R I N N |
| 12 | 183B | 040548 | SEANACA | NACA | TN-1904 | P 0CUCbU | U U U |
| 13 | 14.05 | 1H | 1 3L1711 | 2700-21.7 | N N | .4929 | U N K I N N |
| 14 | 14.31 | 2H | 2 5L1631 | 0900-16.1 | N N | .3721 | U N R I N N |
| 15 | 14.36 | 3H | 1 3L1751 | 1600-19.4 | N N | 1.220 | U N K I N N |
| 16 | 185 | 040648 | ORNACA | NACA | TN-1904 | P 490C | U U U |
| 17 | 20.10 | 1H | 1 3L182 | 8900-10.0 | N N | .612225 | N K I N N |
| 18 | 186 | 040948 | UNCANACA | NACA | TN-1904 | P 20Ac | U U U |
| 19 | 12.51 | 1H | 1 3L171 | 312000-11.1 | N N | .081426 | N R I N N |
| 20 | 12.59 | 2H | 1 3L1631 | 0900-10.0 | N N | .062331 | N R I N N |
| 21 | 13.10 | 3H | 2 5L1501 | 0600-08.9 | N N | .3239 | U N K I N N |
| 22 | 13.40 | 4H | 2 6L1661 | 1200-10.6 | N N | .1637 | U N R I N N |
| 23 | 13.53 | 5H | 3 7L1491 | 2400-12.8 | N N | .1529 | U N R I N N |
| 24 | 187A | 041048 | ORNACA | NACA | TN-1904 | P 605C | U U U |
| 25 | 12.34 | 1H | 2 6L185 | 8900-10.0 | N N | .2420 | U N K I N N |
| 26 | 187B | 041048 | UNVNACA | NACA | TN-1904 | P MAC | U U U |
| 27 | 16.14 | 1H | 3 9L1741 | 3200-11.1 | N N | .121050 | N R I N N |
| 28 | 15.24 | 2H | 3 9L1841 | 3300-15.0 | N N | .1717 | U N K I N N |
| 29 | 15.40 | 3H | 411L1721 | 3100-13.3 | N N | .0813 | U N R I N N |
| 30 | 187C | 041048 | WYNACA | NACA | TN-1904 | P MCu | U U U |
| 31 | 15.59 | 1H | 3 9L1831 | 3000-11.1 | N N | .392230 | N R I N N |
| 32 | 16.05 | 2H | 2 6L1751 | 2900-11.1 | N N | .242122 | N R I N N |
| 33 | 14.41 | 3H | 1 3L1861 | 2700-14.4 | N N | .4516 | U N R I N N |
| 34 | 189 | 041248 | WNNACA | NACA | TN-1904 | P 34CUCbU | U U U |
| 35 | 13.34 | 1H | 1 2L134 | 8000-5.6 | N N | .6522 | U N K I N N |
| 36 | 13.46 | 2H | 2 6L173 | 7000-6.7 | N N | .2018 | U N R I N N |
| 37 | 14.05 | 3H | 512L148 | 8400-6.1 | N N | .2612 | U N R I N N |
| 38 | 14.12 | 4H | 2 6L187 | 9000-6.7 | N N | .2311 | U N K I N N |
| 39 | 15.08 | 5H | 2 5L164 | 7800-8.3 | N N | .6926 | U N R I N N |
| 40 | 189A | 041248 | WNNACA | NACA | TN-1904 | P 34Ac | U U U |
| 41 | 14.36 | 1H | 411L1681 | 0900-11.1 | N N | .0917 | U N R I N N |
| 42 | 14.43 | 2H | 411L1671 | 1100-11.7 | N N | .1420 | U N R I N N |
| 43 | 14.50 | 3H | 3 8L1561 | 1100-11.7 | N N | .162021 | N R I N N |
| 44 | 14.58 | 4H | 617L1671 | 11400-12.8 | N N | .081516 | N R I N N |
| 45 | 193 | 041648 | DETNACA | NACA | TN-1904 | P 6Ac | U U U |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 10

[illegible]

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 11

| Card Column No. | | | | | | | | | | | | | |
|---|------------------------|--------|---------|------------|---------|------|------|-------|-------|-----|----|-----------|-----------|
| 11111111112222222222333333333344444444445555555555666666666677777777778 | | | | | | | | | | | | | |
| 1234567890123456789012345678901234567890123456789012345678901234567890 | | | | | | | | | | | | | |
| Rec. No. | Card (Record) Contents | | | | | | | | | | | | |
| 1 | 204A | 051448 | EMTNACA | NACA | TN-1904 | P | MSc | U | U | U | Mm | #4-6FFmCf | 1 |
| 2 | 13.11 | 1H | 3 | 9L16111300 | -12.3 | N | N | .2616 | U | N | R | N | 2 |
| 3 | 13.17 | 2H | 3 | 8L14712200 | -14.4 | N | N | .2918 | 22 | N | R | N | 2 |
| 4 | 13.27 | 3H | 3 | 9L15613200 | -15.6 | N | N | .2118 | 24 | N | R | N | 2 |
| 5 | 13.32 | 4H | 2 | 6L17013000 | -13.9 | N | N | .2119 | 20 | N | R | N | 2 |
| 6 | 205 | 051548 | EMNNACA | NACA | TN-1904 | P | 6Sc | AcU | U | U | U | cP | #2-3FFmCf |
| 7 | 11.05 | 1H | 3 | 8L160 | 8900 | -5.6 | N | N | .1212 | 13 | N | R | 1 |
| 8 | 11.45 | 2H | 3 | 8L16310900 | -8.9 | N | N | .2712 | 18 | N | R | N | 2 |
| 9 | 11.16 | 3H | 3 | 8L159 | 9900 | -5.6 | N | N | .3215 | 16 | N | R | 2 |
| 10 | 205A | 051548 | WINACA | NACA | TN-1904 | P | 6Cu | CbU | U | U | U | cP | #0-2FFmCf |
| 11 | 11.31 | 1H | 1 | 2L14611200 | -9.4 | N | N | .3817 | 19 | N | R | N | 2 |
| 12 | 11.35 | 2H | 2 | 6L16511200 | -9.4 | N | N | .4617 | 18 | N | R | N | 2 |
| 13 | 11.13 | 3H | 1 | 2L142 | 9800 | -6.7 | N | N | .45 | 915 | N | R | 2 |
| 14 | 12.14 | 4H | 1 | 3L17911800 | -10.0 | N | N | .4512 | 17 | N | R | N | 2 |
| 15 | 12.40 | 5H | 1 | 3L16213600 | -11.1 | N | N | .5413 | 21 | N | R | N | 2 |
| 16 | 206 | 051648 | BNJNACA | NACA | TN-1904 | P | 0Ac | U | U | U | U | mT | PSmOf |
| 17 | 13.33 | 1H | 1 | 4L21814100 | -8.3 | N | N | .0715 | 20 | N | R | N | 1 |
| 18 | 13.37 | 2H | 3 | 8L15814200 | -7.2 | N | N | .2220 | 21 | N | R | N | 2 |
| 19 | 13.45 | 3H | 2 | 5L16214500 | -7.8 | N | N | .2120 | 21 | N | R | N | 2 |
| 20 | 207 | 051848 | WPANACA | NACA | TN-1904 | P | 35Cu | CbU | U | U | U | cP | Nym5FCf |
| 21 | 14.04 | 1H | 1 | 3L16513600 | -12.8 | N | N | 1.219 | U | N | R | N | 2 |
| 22 | 14.07 | 2H | 2 | 5L15613300 | -13.9 | N | N | .8218 | U | N | R | N | 2 |
| 23 | 14.11 | 3H | 2 | 5L13913800 | -12.8 | N | N | 1.119 | U | N | R | N | 2 |
| 24 | 14.20 | 4H | 1 | 3L17413600 | -13.9 | N | N | 1.220 | U | N | R | N | 2 |
| 25 | 14.24 | 5H | 1 | 3L15913600 | -13.3 | N | N | .7817 | 18 | N | R | N | 2 |
| 26 | 14.24 | 6H | 1 | 3L15313800 | -13.3 | N | N | .7915 | 21 | N | R | N | 2 |
| 27 | 14.29 | 7H | 1 | 3L17413900 | -13.3 | N | N | 1.708 | 15 | N | R | N | 2 |
| 28 | 14.35 | 8H | 1 | 3L18014300 | -15.6 | N | N | 1.214 | 15 | N | R | N | 2 |
| 29 | 14.38 | 9H | 1 | 2L14914400 | -15.0 | N | N | 1.013 | 16 | N | R | N | 2 |
| 30 | 14.40 | 10H | 2 | 5L14413300 | -13.3 | N | N | 1.018 | U | N | R | N | 2 |
| 31 | 14.44 | 11H | 1 | 2L13012400 | -11.7 | N | N | .7511 | 19 | N | R | N | 2 |
| 32 | 15.13 | 12H | 1 | 3L15612200 | -8.3 | N | N | | | | | | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 12

| | | -----Card Column No.----- | | | | | | | | | | | | | | | | | | | |
|------|-------|---|--------|-------|---------|---|-------|---|----|---|---|---|---|---|---|---|---|---|---|---|--|
| | | 11111111112222222222333333333344444444445555555555666666666677777777778 | | | | | | | | | | | | | | | | | | | |
| | | 1234567890123456789012345678901234567890123456789012345678901234567890 | | | | | | | | | | | | | | | | | | | |
| Rec. | No. | Card (Record) Contents | | | | | | | | | | | | | | | | | | | |
| 1 | 1 | 112248 | INNACA | NACA | TN-2306 | P | 7Sc | C | U | U | U | U | U | U | U | U | U | U | U | U | |
| 2 | 12.54 | 1HM617L168 | 5000 | -7.2 | N | N | .1614 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 3 | 13.03 | 2HM411L160 | 4500 | -6.1 | N | N | .3212 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 4 | 13.11 | 3HM3 8L160 | 4700 | -6.1 | N | N | .4112 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 5 | 13.20 | 4HM411L160 | 4500 | -6.7 | N | N | .3614 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 6 | 13.43 | 5HM2 6L165 | 5600 | -6.7 | N | N | .5012 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 7 | 13.50 | 6HM3 8L163 | 4900 | -6.7 | N | N | .4412 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 8 | 14.00 | 7HM2 5L160 | 4900 | -7.2 | N | N | .5712 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 9 | 4 | 030849 | LMNACA | NACA | TN-2306 | P | 6Sc | C | U | U | U | U | U | U | U | U | U | U | U | U | |
| 10 | 15.12 | 11HM3 8L164 | 5200 | -3.9 | N | N | .4811 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 11 | 15.18 | 12HM617L165 | 5300 | -3.9 | N | N | .1619 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 12 | 15.23 | 13HM514L165 | 5300 | -3.3 | N | N | .2119 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 13 | 15.30 | 14HM617L162 | 6000 | -5.6 | N | N | .1820 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 14 | 15.36 | 15HM617L162 | 6300 | -5.6 | N | N | .0920 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 15 | 15.44 | 16HM411L165 | 5400 | -4.4 | N | N | .3716 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 16 | 15.56 | 17HM616L160 | 4000 | -2.8 | N | N | .1715 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 17 | 16.09 | 18HM410L150 | 3200 | -2.8 | N | N | .3715 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 18 | 5 | 032249 | LSNACA | NACA | TN-2306 | P | 6Sc | C | U | U | U | U | U | U | U | U | U | U | U | U | |
| 19 | 12.00 | 1HM617L172 | 4200 | -9.4 | N | N | .1618 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 20 | 12.06 | 2HM617L172 | 4500 | -9.4 | N | N | .1323 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 21 | 12.11 | 3HM619L186 | 3800 | -8.9 | N | N | .0727 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 22 | 12.16 | 4HM617L174 | 3400 | -9.4 | N | N | .1717 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 23 | 12.22 | 5HM617L174 | 3700 | -9.4 | N | N | .1016 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 24 | 12.37 | 6HM618L179 | 3400 | -10.6 | N | N | .0612 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 25 | 6 | 032249w | LMNACA | NACA | TN-2306 | P | 6As | C | U | U | U | U | U | U | U | U | U | U | U | U | |
| 26 | 17.57 | 1HM619L190 | 8700 | -4.4 | N | N | .0616 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 27 | 19.06 | 2HM619L187 | 9300 | -5.6 | N | N | .1816 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 28 | 7 | 032549MSP | NACA | NACA | TN-2306 | P | 6Sc | C | U | U | U | U | U | U | U | U | U | U | U | U | |
| 29 | 10.24 | 1HM618L159 | 3200 | -2.8 | N | N | .0710 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 30 | 11.22 | 2HM2 5L161 | 4400 | -5.0 | N | N | .5010 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 31 | 11.25 | 3HM513L161 | 4500 | -6.1 | N | N | .2714 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 32 | 11.30 | 4HM411L160 | 4400 | -6.7 | N | N | .3418 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 33 | 11.35 | 5HM514L174 | 4300 | -6.1 | N | N | .2813 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 34 | 11.40 | 6HM412L174 | 4300 | -6.1 | N | N | .2912 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 35 | 11.43 | 7HM411L161 | 4500 | -5.6 | N | N | .3615 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 36 | 11.47 | 8HM513L161 | 4400 | -5.6 | N | N | .2513 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 37 | 11.50 | 9HM616L162 | 4200 | -4.4 | N | N | .1714 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 38 | 11.54 | 10HM616L162 | 4200 | -4.4 | N | N | .1211 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 39 | 11.57 | 11HM513L162 | 4200 | -4.4 | N | N | .2312 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 40 | 12.02 | 12HM411L165 | 4200 | -5.6 | N | N | .3512 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 41 | 12.06 | 13HM3 8L165 | 4200 | -5.6 | N | N | .4012 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 42 | 12.10 | 14HM3 8L167 | 4400 | -5.0 | N | N | .4010 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 43 | 12.14 | 15HM513L161 | 4400 | -5.0 | N | N | .2211 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 44 | 12.20 | 16HM411L161 | 4400 | -5.0 | N | N | .2910 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 45 | 12.25 | 17HM411L162 | 4400 | -5.0 | N | N | .3110 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 46 | 8 | 032749 | MNNACA | NACA | TN-2306 | P | 6Sc | C | U | U | U | U | U | U | U | U | U | U | U | U | |
| 47 | 14.00 | 1HM513L159 | 3900 | -5.0 | N | N | .2514 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 48 | 14.06 | 2HM513L157 | 4100 | -3.8 | N | N | .2614 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 49 | 14.12 | 3HM4 8L159 | 3800 | -4.4 | N | N | .3412 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 50 | 14.17 | 4HM513L159 | 3800 | -4.4 | N | N | .2517 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 51 | 14.22 | 5HM411L162 | 3800 | -5.6 | N | N | .3016 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 52 | 14.29 | 6HM411L165 | 3800 | -5.6 | N | N | .3612 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 53 | 14.34 | 7HM513L164 | 3800 | -5.6 | N | N | .2413 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 54 | 15.16 | 8HM616L165 | 3800 | -3.9 | N | N | .1118 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 55 | 15.22 | 9HM513L154 | 3800 | -3.3 | N | N | .2116 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 56 | 15.27 | 10HM513L169 | 3800 | -5.0 | N | N | .2213 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 57 | 15.33 | 11HM513L155 | 3800 | -3.3 | N | N | .2213 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 58 | 15.38 | 12HM513L160 | 3600 | -5.0 | N | N | .2414 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 59 | 15.43 | 13HM615L155 | 3600 | -3.3 | N | N | .1914 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |
| 60 | 15.48 | 14HM616L160 | 3400 | -3.3 | N | N | .1412 | U | UR | N | N | N | N | N | N | N | N | N | N | N | |

11111111112222222222333333333344444444445555555555666666666677777777778
1234567890123456789012345678901234567890123456789012345678901234567890

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 13

| | | Card Column No. | | | | | | | | | | | | | | | | | | | | | |
|----------|-------|---|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|---|-----------|---|--|
| | | 11111111112222222222333333333344444444445555555555666666666677777777778 | | | | | | | | | | | | | | | | | | | | | |
| | | 1234567890123456789012345678901234567890123456789012345678901234567890 | | | | | | | | | | | | | | | | | | | | | |
| Rec. No. | | Card (Record) Contents | | | | | | | | | | | | | | | | | | | | | |
| 1 | 9 | 032749MSPNACA NACA TN-2306 P 8 5a C U | | | | | | | | | | | | | | | | | | c | 1-2FFmLc | 1 | |
| 2 | 19.13 | 1H#4 8L164 3400 -3.3 N N .30 8 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 3 | 19.18 | 2H#513L160 3600 -3.9 N N .2410 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 4 | 19.23 | 3H#513L161 4200 -5.0 N N .2210 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 5 | 19.28 | 4H#513L163 4500 -5.0 N N .2012 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 6 | 19.33 | 5H#513L154 4800 -3.9 N N .2310 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 7 | 19.38 | 6H#513L166 5400 -5.0 N N .2016 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 8 | 19.43 | 7H#513L160 3600 -3.9 N N .2114 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 9 | 19.48 | 8H#616L160 3600 -3.3 N N .1119 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 10 | 19.52 | 9H#513L162 4300 -4.4 N N .2020 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 11 | 19.59 | 10H#616L160 4300 -3.9 N N .1116 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 12 | 10 | 041849MFDNACA NACA TN-2306 P 95a C U | | | | | | | | | | | | | | | | | | c | W0-1f5rLc | 1 | |
| 13 | 12.24 | 1H#3 8L159 4500 -3.9 N N .4816 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 14 | 12.29 | 2H#3 8L169 5000 -3.9 N N .4415 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 15 | 12.34 | 3H#3 8L164 5000 -3.9 N N .4011 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 16 | 12.50 | 4H#3 8L169 4800 -3.9 N N .4612 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 17 | 12.40 | 5H#3 8L168 4700 -3.9 N N .4814 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 18 | 10A | 041849MFDNACA NACA TN-2306 P 9Cu C U | | | | | | | | | | | | | | | | | | c | WU-1f5rLc | 1 | |
| 19 | 12.45 | 1H#2 8L169 5000 -4.4 N N .5911 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 20 | 12.55 | 2H#2 5L163 4700 -3.9 N N .5012 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 21 | 11 | 041849ADONACA NACA TN-2306 P 17ba C U | | | | | | | | | | | | | | | | | | c | Wym4FFmCf | 1 | |
| 22 | 13.16 | 1H#3 8L168 6400 -7.8 N N .42 8 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 23 | 13.50 | 3H#619L187 7800 -8.9 N N .19 8 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 24 | 14.05 | 4H#412L174 7200 -11.7 N N .3411 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 25 | 11A | 041849ADONACA NACA TN-2306 P 17Cu C U | | | | | | | | | | | | | | | | | | c | Wym4FFmCf | 1 | |
| 26 | 14.24 | 5H#2 6L174 7200 -11.7 N N .7011 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 27 | 13.32 | 2H#514L162 7500 -8.3 N N 1.3 5 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 28 | 12 | 052749 LENACA NACA TN-2306 P 6AaAc C U | | | | | | | | | | | | | | | | | | c | U | 1 | |
| 29 | 14.53 | 1H#621L211 7600 -7.2 N N .1612 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 30 | 15.08 | 2H#518L211 8800 -9.4 N N .24 7 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 31 | 15.17 | 3H#621L211 9000 -9.4 N N .0014 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 32 | 13 | 120749CLENACA NACA TN-2306 P 65a C U | | | | | | | | | | | | | | | | | | c | W0-2FFmCf | 1 | |
| 33 | 13.54 | 1H#413L188 5000 -10.6 N N .3114 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 34 | 14 | 011950ORFNACA NACA TN-2306 P 0bt C U | | | | | | | | | | | | | | | | | | c | W2FSmCf | 1 | |
| 35 | 16.05 | 1H#618L180 3000 -1.0 N N .1314 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 36 | 15 | 013050CLENACA NACA TN-2306 P 65a C U | | | | | | | | | | | | | | | | | | c | Hp | 1 | |
| 37 | 12.45 | 1H#617L167 4000 -11.7 N N .06 9 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 38 | 16 | 013150CLENACA NACA TN-2306 P 65a C U | | | | | | | | | | | | | | | | | | c | W3aFWkLc | 1 | |
| 39 | 11.58 | 1H#817L176 2000 -3.9 N N .15 914 UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 40 | 12.15 | 2H#515L176 2000 -6.1 N N .26 914 URF N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 41 | 12.24 | 3H#515L176 3000 -6.7 N N .2310 U UR N N NN N U | | | | | | | | | | | | | | | | | | U | U U U U | 2 | |
| 42 | 17 | 020750CLENACA NACA TN-2306 P 65a C U | | | | | | | | | | | | | | | | | | c | HpR | 1 | |
| | | | | | | | | | | | | | | | | | | | | | | | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 15

| Rec. No. | | Card (Record) | | Contents | | Card Column No. | |
|----------|-----------|------------------|--------------|----------|-----------|-----------------|---|
| 1 | 19 | 020950c | OHNAACA NACA | TN-2306 | P115c | C | U |
| 2 | 14.43 | 1HM618L183 | 3700 | -2.8 | 121017 | URF | N |
| 3 | 14.54 | 2HM3 9L176 | 2700 | -3.3 | .45 820 | URF | N |
| 4 | 14.58 | 3HM3 9L176 | 2700 | -3.9 | .46 821 | URF | N |
| 5 | 15.12 | 4HM412L165 | 2600 | -3.3 | .33 816 | URF | N |
| 6 | 15.23 | 5HM412L188 | 2800 | -3.9 | .381126 | URF | N |
| 7 | 15.31 | 6HM2 6L171 | 2800 | -3.9 | .60 824 | URF | N |
| 8 | 15.38 | 7HM2 6L171 | 2800 | -4.4 | .52 824 | URF | N |
| 9 | 15.44 | 8HM412L187 | 2000 | -2.8 | .31 6 U | UR | N |
| 10 | 20 | 021050MFD | NACA NACA | TN-2306 | P135c | C | U |
| 11 | 14.18 | 1HM515L179 | 3700 | -4.4 | .241016 | URF | N |
| 12 | 14.23 | 2HM412L173 | 4000 | -5.6 | .39 820 | URF | N |
| 13 | 14.23 | 3HM3 9L176 | 3500 | -6.1 | .42 817 | URF | N |
| 14 | 21 | 032350c | OHNAACA NACA | TN-2306 | P105c | C | U |
| 15 | 13.02 | 1HM513L157 | 4000 | -2.8 | .241126 | URF | N |
| 16 | 13.09 | 2HM615L151 | 4200 | -3.3 | .1612 U | UR | N |
| 17 | 22 | 032950w | WVNAACA NACA | TN-2306 | P 95c | C | U |
| 18 | 10.31 | 1HM411L172 | 7000 | -12.2 | .301119 | URF | N |
| 19 | 10.40 | 2HM2 5L164 | 7000 | -11.1 | .50 823 | URF | N |
| 20 | 10.44 | 3HM411L163 | 7000 | -12. | .3114 U | URF | N |
| 21 | 10.49 | 4HM616L163 | 7000 | -12.2 | .1410 U | UR | N |
| 22 | 10.56 | 5HM411L163 | 7000 | -11.7 | .321422 | URF | N |
| 23 | 11.03 | 6HM411L169 | 7000 | -11.7 | .331018 | URF | N |
| 24 | 11.10 | 7HM2 5L164 | 7000 | -11.1 | .5310 U | UR | N |
| 25 | 11.15 | 8HM411L173 | 7000 | -10.6 | .351115 | URF | N |
| 26 | 11.23 | 9HM3 9L173 | 7000 | -10.6 | .4311 U | UR | N |
| 27 | 11.37 | 10HM411L173 | 7000 | -10.0 | .3811 U | UR | N |
| 28 | F42 | 041348n | UTNACA NACA | TN-1383 | P MCu | I | U |
| 29 | 1450+129H | 12V13911614V0408 | | | .1606 U | U | R |
| 30 | 1540+129H | 12V13911614V0408 | | | .3 05 U | U | R |
| 31 | 196 | 041948w | WVNAACA NACA | TN-1904 | P MAc | U | U |
| 32 | 09.29 | 1H 612L11513400 | -11.7 | | .181517 U | RI | N |
| 33 | 09.43 | 2H 619L19213900 | -15.0 | | .0915 U | RI | N |
| 34 | 09.51 | 3H 3 8L16213700 | -14.4 | | .2923 U | RI | N |
| 35 | 10.03 | 4H 1 3L17613700 | -15.0 | | .33212/ N | RI | N |
| 36 | 10.12 | 5H 2 6L17813700 | -14.4 | | .182123 N | RI | N |
| 37 | 10.16 | 6H 3 8L15412900 | -11.1 | | .2925 U | RI | N |
| 38 | 10.25 | 7H 1 3L16312600 | -10.6 | | .121418 N | RI | N |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 15

| -----Card Column No.----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|--|---------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|----------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| 11111111122222222223333333333444444444555555555666666666777777777888888888999999999 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rec. | No. | Card (Record) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Contents | | | | | | | | | | | | | | | | | | | |
| 1 | A711AC1020679MSP MRI MRI 79 DV-1679 P 7 St B U N U | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | U U cP U | | | | | | | | | | | | | | | | | | | |
| 2 | 12:44 1J 2 3L 90 4900-10.4 N N .03122464 A N N Z NN N.03 U RO U U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | 12:47 2A 4 6L 90 4950-10.6 N N .06223616 A N N Z NN N.05 U RO X U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 12:54 3G 2 3L 90 5100-10.4 N N .07233313 A N N Z NN N.04 U RO U U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | 12:56 4D 4 6L 85 5150-10.2 N N .17213363 A N N Z NN N.10 U RO.12 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | 13:01 5D 710L 85 5150 -9.5 N N .08152795 A N N Z NN N.05 U RO.07 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | 13:08 6A 913L 85 5250 -9.3 N N .19213664 A N N Z NN N.10 U RO.13 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | A711AC2020679MSP MRI MRI 79 DV-1679 P 7 St B U N U | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | U U cP U | | | | | | | | | | | | | | | | | | | |
| 9 | 13:19 1J1522L 90 5000-10.3 N N .1/1933 77 A N N Z NN N.08 U RO.11 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | 13:37 2J 4 6L 90 5000-11.5 N N .05 927219 A N N Z NN N.02 U RO.06 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | 13:43 3A 6 9L 88 4900-11.3 N N .06 816245 A N N Z NN N.03 U RO.04 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | A1518C1021379MSP MRI MRI 79 DV-1679 P 7 NCStC U N U | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | U U c Hp | | | | | | | | | | | | | | | | | | | |
| 13 | 14:19 1G1216L 82 5450 -5.4 N N .15142416U A N N Z NN N.13 U RO.15 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | 14:31 2G 5 7L 82 5400 -5.6 N N .141118270 A N N Z NN N.11 U RO.13 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | 14:36 3A1520L 82 5500 -5.4 N N .151324195 A N N Z NN N.11 U RO.13 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | A1518C2021379MSP MRI MRI 79 DV-1679 P 7 NCStC U N U | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | U U c Hp | | | | | | | | | | | | | | | | | | | |
| 17 | 14:56 1A3445L 80 5400 -5.2 N N .111121195 A N N Z NN N.07 U RO.09 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 18 | A1418C1021379MSP MRI MRI 79 DV-1679 P 7 NCStC U N U | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | U U c Hp | | | | | | | | | | | | | | | | | | | |
| 19 | 10:44 1J1320L 90 4950 -5.5 N N .062030 34 A N N Z NN N.10 U RO.10 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | 10:58 2A1216L 82 5300 -5.6 N N .071021178 A N N Z NN N.09 U RO.12 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 21 | A1418C2021379MSP MRI MRI 79 DV-1679 P 7 NCStC U N U | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | U U c Hp | | | | | | | | | | | | | | | | | | | |
| 22 | 11:14 1D1826L 88 5400 -5.6 N N .101127201 A N N Z NN N.12 U RO.13 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23 | 11:32 2A 3 5L 90 5200 -6.8 N N .171836132 A N N Z NN N.17 U RO.20 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | A1720C1021579MSP MRI MRI 79 DV-1679 P 7 St B U N U | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | U U c NWPGRAHc | | | | | | | | | | | | | | | | | | | |
| 25 | 11:33 1J 2 3L 80 8000 -9.0 N N .083042 81 A N N Z NN N.07 U RO N N N U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 26 | A1720C1021579MSP MRI MRI 79 DV-1679 P 7 St C U N U | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | U U c NWPGRAHc | | | | | | | | | | | | | | | | | | | |
| 27 | 11:37 2G 3 4L 80 8600 -8.8 N N .112136 46 A N N Z NN N.08 U RO.08 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 28 | 11:40 3D 4 5L 8010000 -9.1 N N .111936 75 A N N Z NN N.08 U RO.08 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 29 | 11:44 4G 5 7L 80 8980 -8.2 N N .122336 52 A N N Z NN N.09 U RO.10 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 30 | 11:50 5G 1 2L 80 8980 -8.2 N N .081830122 A N N Z NN N.08 U RO.08 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | 11:51 6G 3 4L 82 9000 -7.6 N N .052133 46 A N N Z NN N.03 U RO.06 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 32 | 11:54 7G 1 2L 82 9000 -7.6 N N .081730132 A N N Z NN N.06 U RO.04 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 33 | 11:55 8G 2 3L 81 9000 -7.6 N N .132033 56 A N N Z NN N.09 U RO.09 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 34 | 11:58 9G 6 8L 80 9050 -7.9 N N .141833 85 A N N Z NN N.09 U RO.12 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 35 | 12:05 10A 5 7L 80 8950 -8.0 N N .082136 53 A N N Z NN N.07 U RO.09 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 36 | A1720C2021579MSP MRI MRI 79 DV-1679 P 7 St C U N U | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | U U c NWPGRAHc | | | | | | | | | | | | | | | | | | | |
| 37 | 12:12 1A1826L 82 8030 -8.9 N N .102436 53 A N N Z NN N.06 U RO.09 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 38 | A2329CA031079SYR MRI MRI 79 DV-1679 P 4st B GZ -2.7 U N U | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | U U c Of | | | | | | | | | | | | | | | | | | | |
| 39 | 09:46 1G 3 4L 71 8000 -6.4.4112.421421351 A N N Z NN N.40 U RO.43 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 40 | 09:49 2A 2 3L 80 7630 -6.0.1212.121221180 A N N Z NN N.08 U RO X U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 41 | 10:00 3D 4 5L 82 7660 -6.2.2212.251321355 A N N Z NN N.20 U RO.20 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 42 | 10:03 4D 912L 82 7660 -5.4.2712.33163366 A N N Z NN N.25 U RO.30 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 43 | 10:12 5A 311L 82 7500 -5.3.2612.251321283 A N N Z NN N.20 U RO.24 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 44 | 10:26 6E1318L 82 7600 -5.3.2112.241421280 A N N Z NN N.15 U RO.19 U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 45 | 10:39 7E 1 1L 90 6900 -4.1.1112.041018139 A N N Z NN N.04 U RO X U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 46 | 10:40 8A 1 1L 90 6200 -2.7.0412.02 712119 A N N Z NN N.01 U RO X U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 47 | A2022CA022079MSP MRI MRI 79 DV-1679 P 7st C U N U | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | U U c #1NWKLc | | | | | | | | | | | | | | | | | | | |
| 48 | 13:35 1D 812L 88 2750 -2.5 N N .171933132 A N N Z NN N.20 U RO X U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 49 | 13:43 2D 812L 88 2860 -2.8 N N .151424191 A N N Z NN N.17 U RO X U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 50 | 13:50 3A 2 3L 88 2600 -2.8 N N .071224178 A N N Z NN N.08 U RO X U 10 U U 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 51 | 16:42 052280dWA MRI MRI 80 FR-1768 P 0 Cu S#35 #0 100 U mP #5FCf | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 52 | 16:42 1A 3 9L18010000-11.0.32JW.3221 U108 f N N NN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)

| Card Column No. | | | Card (Record) | | | Contents | | | Contents | | |
|-----------------|-------|----------------------|------------------|-----------|------|----------|---|---|----------|---|---|
| 1 | 17.03 | 052380WMA MRI MRI 80 | FR-1788 P | 0 | CU | S | U | U | U | U | U |
| 2 | 17.14 | 1A 1 3L180 8800 | -8.4 | 36JW.4618 | U182 | F | N | N | N | N | N |
| 3 | 17.17 | 2A 2 6L175 8700 | -7.5 | 45JW.4518 | U197 | F | N | N | N | N | N |
| 4 | 17.20 | 3A 2 6L170 8800 | -7.2 | 23JW.2417 | U150 | F | N | N | N | N | N |
| 5 | 17.21 | 4A 1 3L190 8700 | -7.5 | 69JW.4417 | U248 | F | N | N | N | N | N |
| 6 | 17.31 | 5B 412L175 7400 | -4.5 | X JW.3216 | U254 | F | N | N | N | N | N |
| 7 | 17.35 | 6E 3 9L175 7700 | -3.2 | X JW.1114 | U183 | F | N | N | N | N | N |
| 8 | 17.37 | 7A 2 6L175 8300 | -3.5 | X JW.0613 | U132 | F | N | N | N | N | N |
| 9 | 09.16 | 040180eKS MRI MRI 80 | FR-1766 P32515eC | U | U | U | U | U | U | U | U |
| 10 | 09.16 | 1G 618L175 9000 | -6.3 | N N .1316 | U118 | F | N | N | N | N | N |
| 11 | 09.23 | 2G 3 9L175 9200 | -9.5 | N N .2616 | U258 | F | N | N | N | N | N |
| 12 | 09.28 | 2AE 1 3L18010300 | -9.2 | N N .1415 | U145 | F | N | N | N | N | N |
| 13 | 09.29 | 3E 2 6L18511100 | -10.3 | N N .0524 | U 36 | F | N | N | N | N | N |
| 14 | 09.31 | 4G 2 6L17510100 | -10.5 | N N .0826 | U 49 | F | N | N | N | N | N |
| 15 | 09.32 | 5G 1 3L18010300 | -10.3 | N N .2225 | U125 | F | N | N | N | N | N |
| 16 | 09.33 | 6J 2 6L18510200 | -10.4 | N N .0924 | U 58 | F | N | N | N | N | N |
| 17 | 09.38 | 7A 1 3L18010000 | -9.6 | N N .0627 | U 27 | F | N | N | N | N | N |
| 18 | 14.23 | 040180eNB MRI MRI 80 | FR-1766 P32515eC | U | U | U | U | U | U | U | U |
| 19 | 14.23 | 1E 411L185 7400 | -4.4 | 10JW.1215 | U176 | F | N | N | N | N | N |
| 20 | 14.29 | 2A 2 6L175 7000 | -4.2 | 06JW.0207 | U162 | F | N | N | N | N | N |
| 21 | 14.52 | 3P N NP155 6800 | -4.5 | 10JW.1615 | U172 | F | N | N | N | N | N |
| 22 | 14.53 | 4P N NP155 6300 | -3.6 | 10JW.1214 | U143 | F | N | N | N | N | N |
| 23 | 14.54 | 5P N NP155 5800 | -2.6 | 12JW.0913 | U130 | F | N | N | N | N | N |
| 24 | 14.56 | 6H 411L180 6500 | -4.0 | 13JW.0915 | U154 | F | N | N | N | N | N |
| 25 | 15.01 | 7D 3 8L180 6600 | -4.3 | 15JW.0711 | U218 | F | N | N | N | N | N |
| 26 | 15.03 | 8A 2 6L170 6500 | -3.6 | 13JW.0307 | U253 | F | N | N | N | N | N |
| 27 | 00.42 | 123179wOR MRI MRI 80 | FR-1738 P | 75e | U | U | U | U | U | U | U |
| 28 | 00.42 | 1A 81/L165 8100 | -4.8 | N N .2232 | U 89 | F | N | N | N | N | N |
| 29 | 00.51 | 2G 1 3L180 9800 | -6.0 | N N .3131 | U 45 | F | N | N | N | N | N |
| 30 | 00.52 | 3A1030L180 9800 | -4.5 | N N .1028 | U 16 | F | N | N | N | N | N |
| 31 | 01.07 | 4J 1 3L18511800 | -5.9 | N N .0928 | U 13 | F | N | N | N | N | N |
| 32 | 01.10 | 5E 2 6L18511400 | -7.5 | N N .1030 | U 15 | F | N | N | N | N | N |
| 33 | F372 | 010280PAE MRI MRI 80 | FR-1738 P | 75e | U | U | U | U | U | U | U |
| 34 | 13.48 | 1P N NP13011000 | -10.6 | N N .0215 | U 22 | F | N | N | N | N | N |
| 35 | 13.49 | 2P N NP13111950 | -13.0 | N N .0620 | U 27 | F | N | N | N | N | N |
| 36 | 13.50 | 3P N NP13512550 | -14.2 | N N .1322 | U 43 | F | | | | | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 1/

[illegible]

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 18

| Card Column No. | | Card (Record) Contents | |
|---|--|------------------------|--|
| 11111111112222222222333333333344444444445555555555666666666677777777778 | | | |
| 1234567890123456789012345678901234567890123456789012345678901234567890 | | | |
| Rec. No. | | | |
| 1 | Cloud1 120380cLM UMY Priv Comm 5/81 S 6 #ScC 16 -7.3 39-10.8 cPHp,LeCldCOLM,1391 | | |
| 2 | 13.53 A1J 822L157 3460-10.6.20JW.311317131 F .8.06<1 NN N 8c RO m N CS U U 2 | | |
| 3 | 14.29 B3J 412L163 2410 -8.4.06JW.071012132 F .6.19#3 NN N 3c RO m N CS U U 2 | | |
| 4 | 150012C1P N NP155 3590-10.6.13JW.1814 m109 F .3 0 0 NN N U RO.09 N CS U U 2 | | |
| 5 | 150048C2P N NP157 3050 -9.9.19JW.1814 m145 F .5 .1 1 NN N #6c RO.17 N CS U U 2 | | |
| 6 | 150124C3P N NP152 2615 -9.0.11JW.1011 m144 F .7 .1 1 NN N #4c RO.13 N CS U U 2 | | |
| 7 | 150218C4P N NP145 2295 -8.2.03JW.04 8 m123 F .9 .2 3 NN N #2c RO.06 N CS U U | | |
| 8 | 150318C5P N NP149 2830 -9.0.17JW.1612 m153 F .5 .1 0 NN N #6c RO.17 N CS U U | | |
| 9 | 150336C6P N NP150 3235 -9.7.16JW.1613 m129 F .8 .1 0 NN N #6c RO.17 N CS U U | | |
| 10 | 150400C7P N NP139 3870-10.8.25JW.2416 m122 F .8 .1 0 NN N #6c RO.26 N CS U U 2 | | |
| 11 | 15.26 D3D 1 2L166 2945 -8.8.05JW.07 9 m144 F .4 .1<1 NN N 4c RO m N CS U U 2 | | |
| 12 | 15.27 D4G 3 9L161 2940 -8.7.11JW.141214143 F .5 .1<1 NN N 5c RO m N CS U U 2 | | |
| 13 | 153148E1P N NP163 2670 -8.7.12JW.1210 m214 F .1 .3 3 NN N #6c RO.13 N CS U U 2 | | |
| 14 | 153224E2P N NP164 2140 -7.9.09JW.06 7 m285 F .1 .4 5 NN N #3c RO.09 N CS U U 2 | | |
| 15 | 153254E3P N NP166 1680 -7.3.01JW.03 6 m238 F .1 .3 2 NN N #2c RO.05 N CS U U 2 | | |
| 16 | Cloud2 120380cLM UMY Priv Comm 5/81 S 6 #ScB#16m-7.3 35-10.5 cPHp,LeCldCOLM,1351 | | |
| 17 | 14.02 A20 2 5L166 3460-10.4.29JW.2513 m244 F .6.05<1 NN N 15c RO m N CS U U 2 | | |
| 18 | 14.04 A3A 2 5L163 3440-10.5.13JW.1110 m175 F .0.01<1 NN N 4c RO m N CS U U 2 | | |
| 19 | 15.20 D1J 1 2L170 2945 -9.3.07JW.03 6 9190 F .1 0 0 NN N 0 RO.02 N CS U U 2 | | |
| 20 | 15.22 D2J 1 2L168 2925 -9.1.07JW.04 7 9147 F .1 0 0 NN N 0 RO.01 N CS U U 2 | | |
| 21 | Cloud3 120380cLM UMY Priv Comm 5/81 S 6 #ScC 16 -7.3#33m-9.9 cP Hp,LeCldCOLM,121 | | |
| 22 | 14.35 B4G 1 4L166 2410 -9.6.03JW.05 81125 F .5.15#3 NN N <1c RO.07 N CS U U 2 | | |
| 23 | 14.37 B5A.6 2L163 2420-10.1.02JW.03 710134 F .4 .1#1 NN N <1c RO.05 N CS U U 2 | | |
| 24 | 153554E6P N NP134 1550 -7.6 0JW.02 5 m270 F .8 .2 0 NN N 0 RO 0 N CS U U 2 | | |
| 25 | 153612E7P N NP128 2015 -8.5.01JW.04 6 m284 F .5 .2 1 NN N 0 RO.03 N CS U U 2 | | |
| 26 | 153642E8P N NP139 2525 -9.2.05JW.07 8 m224 F .8 .1 1 NN N <1c RO.06 N CS U U 2 | | |
| 27 | 15.37 E9A 2 6L162 2925 -9.7.09JW.04 813131 F .3 0<1 NN N 2c RO.08 N CS U U 2 | | |
| 28 | Cloud1 121080cLM UMY Priv Comm 5/81 S 6 Sc B#22 m-8 50-14.0cP Hp#4FCf,150 | | |
| 29 | 15.35 A1J 3 7L159 4830-14.1.34JW.2710 m460 F .8.14 0 NN N 9c RO.25 N CS U U 2 | | |
| 30 | 15.39 A2J.8 2L158 4870-14.1.29JW.2510 m450 F .7.1 0 NN N 7c RO.22 N CS U U 2 | | |
| 31 | 15.43 A3A.8 2L159 4820-13.6.32JW.2410 m470 F1.4.25<1 NN N 7c RO.25 N CS U U 2 | | |
| 32 | Cloud2 121080cLM UMY Priv Comm 5/81 S 6 Sc B 23 -8.9 46-13.4cP Hp#4FCf,146 | | |
| 33 | 154730B1P N NS158 4555-13.3.20JW.16 9 m384 F .3 0 0 NN N #6c RO.10 N CS U U 2 | | |
| 34 | 154818B2P N NS162 4050-12.1.34JW.3110 m553 F .2 0 0 NN N #6c .3.31 N CS U U 2 | | |
| 35 | 15.49 B4J 1 3L158 3860-12.0.09JW.06 7 m238 F1.4.2 1 NN N 3c RO.07 N CS U U 2 | | |
| 36 | 15.51 B6E 923L154 3800-11.9.21JW.20 9 m513 F1.6.3 m NN N 6c RO m N CS U U 2 | | |
| 37 | 160106B7P N NS154 3280-11.0.08JW.12 8 m508 F2.2.6 12 NN N #2c RO.14 N CS U U 2 | | |
| 38 | 160130B8P N NS160 2785-10.0 0 JW.05 6 m410 F2.0.7 9 NN N #2c RO.07 N CS U U 2 | | |
| 39 | 160218B9P N NS168 2445 -9.2.02JW.02 5 m163 F1.9.5 8 NN N 0c RO.02 N CS U U 2 | | |
| 40 | 160536C1P N NS140 2515 -9.6 0 JW.02 6 m208 F2.1.5 3 NN N 0c RO.04 N CS U U 2 | | |
| 41 | 160600C2P N NS149 3045-10.9.11JW.09 7 m575 F1.5.4 0 NN N #3c RO.13 N CS U U 2 | | |
| 42 | 16.06 C4E 615L155 3330-11.3.22JW.21 9 m560 F .7.2 <1 NN N 6c RO m N CS U U 2 | | |
| 43 | 16.13 C6E 3 7L155 2795 -9.1.23JW.16 8 m590 F1.0.2 2 NN N 6c RO m N CS U U 2 | | |
| 44 | 161624C7P N NP165 2395 -8.0.14JW.07 6 m471 F1.4.3 #2 NN N #3c RO.11 N CS U U 2 | | |
| 45 | Cloud1 121380MKG UMY Priv Comm 5/81 S 6 Sc U 44-15.4 56-17.4cA Hp#6FFmCf,156 | | |
| 46 | 163954A1P N NP172 4475-15.5.03JW.01 7 m108 F1.1 .3 0 NN N 0 RO 0 N CS U U 2 | | |
| 47 | 164042A2P N NP166 5025-16.2.28JW.2413 m204 F1.2 .3 0 NN N #15cRO.20 N CS U U 2 | | |
| 48 | 164136A3P N NP158 5545-17.4.42JW.3815 m207 F1.0 .2 0 NN N # RO.28 N CS U U 2 | | |
| 49 | 164836B1P N NP178 5335-17.6.11JW.1213 m105 F .7 .2 0 NN N #6c RO.09 N CS U U 2 | | |
| 50 | 16.49 B3E 411L166 4745-16.1.07JW.0910 m155 F1.5 .4 m NN N 3.4cRO m N CS U U 2 | | |
| 51 | Cloud3 121380MKG UMY Priv Comm 5/81 S 6 Sc B 41-14.5#50m-17 cA Hp#6FFmCf | | |
| 52 | 180754C1P N NP164 4070-14.7.09JW.05 8 m204 F1.3 0 1 NN N #3c RO.02 N CS U U 2 | | |
| 53 | 18.09 C3G 514L171 4730-15.9.13JW.1210 m181 F .9 .2 m NN N 4.3cRO m N CS U U 2 | | |
| 54 | 18.14 C4J 2 7L171 4715-15.6.07JW.05 8 m149 F .4 .1 m NN N 2.5cRO m N CS U U 2 | | |
| 55 | 18.18 C5J 2 5L174 4730-15.5.09JW.1010 m157 F .8 .1 m NN N #4c RO m N CS U U 2 | | |
| 56 | 18.22 C6J 1 4L175 4720-15.2.06JW.04 7 m165 F1.2 .2 2 NN N 3.0cRO m N CS U U 2 | | |
| 57 | 18.23 C7D 1 4L172 4710-15.1.12JW.1111 m169 F1.5 .4 3 NN N 7c RO m N CS U U 2 | | |
| 58 | 18.25 C8A 3 8L168 4706-14.8.24JW.2313 m183 F1.3 .3 m NN N 12cRO m N CS U U 2 | | |
| 11111111112222222222333333333344444444445555555555666666666677777777778 | | | |
| 1234567890123456789012345678901234567890123456789012345678901234567890 | | | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 19

| | | Card Column No. | | | | | | | | | | | | | | | | | | | | | | |
|------|-----------|--|-------|-----------|------------|------|------|----|----|-----------|---------------------|----------------------|------------------------------|----|-----|-----|------|-----|-----|----|----|---|---|---|
| | | 11111111112222222222333333333344444444445555555555666666666677777777778 | | | | | | | | | | | | | | | | | | | | | | |
| | | 12345678901234567890123456789012345678901234567890123456789012345678901234567890 | | | | | | | | | | | | | | | | | | | | | | |
| Rec. | No. | Card (Record) Contents | | | | | | | | | | | | | | | | | | | | | | |
| 1 | Cloud2 | 121380cLM | UWY | Priv | Comm | 5/81 | S | 6 | Sc | B<36 | U | *45*-15 cA Hp*6FFmCf | | | | | | | | | | 1 | | |
| 2 | 17:03 | B5J | 1 | 2L166 | 3720-13.8 | 03JW | 04 | 9 | m | 94 | F3.5 | .7 | 4 | NN | N | 0 | RO | N | CS | U | U | 2 | | |
| 3 | 17:05 | B6D | 3 | 8L164 | 3725-13.4 | 13JW | 1110 | | m | 211 | F3.0 | .8 | m | NN | N | 4.8 | cRO | m | N | CS | U | U | 2 | |
| 4 | 17:08 | B7H | 3 | 9L169 | 3710-14.0 | 08JW | 05 | 8 | m | 130 | F2.1 | .5 | m | NN | N | 2.3 | cRO | m | N | CS | U | U | 2 | |
| 5 | 17:12 | B8J | 3 | 9L167 | 3705-14.3 | 17JW | 1411 | | m | 205 | F1.6 | .3 | m | NN | N | 5.0 | cRO | m | N | CS | U | U | 2 | |
| 6 | 17:16 | B9J | 1 | 3L172 | 3685-14.7 | 06JW | 09 | 9 | m | 140 | F | .5 | .1 | 4 | NN | N | *3c | RO | .07 | N | CS | U | U | 2 |
| 7 | 17:17 | 10J | 9 | 2L170 | 3695-14.6 | 14JW | 1410 | | m | 174 | F | .4 | .1 | 3 | NN | N | *3c | RO | .09 | N | CS | U | U | 2 |
| 8 | 17:23 | 11J | 1 | 4L170 | 3695-14.6 | 05JW | 0910 | | m | 142 | F1.1 | .2 | 1 | NN | N | *5c | RO | .08 | N | CS | U | U | 2 | |
| 9 | 17:25 | 12J | 7 | 2L174 | 3715-14.5 | 16JW | 1511 | | m | 197 | F1.0 | .1 | .7 | NN | N | *4c | RO | .13 | N | CS | U | U | 2 | |
| 10 | 17:26 | 13J | 2 | 6L170 | 3705-14.3 | 16JW | 1511 | | m | 231 | F | .8 | .1 | <1 | NN | N | *10c | RO | m | N | CS | U | U | 2 |
| 11 | 17:28 | 14G | 2 | 8L169 | 3715-14.1 | 17JW | 1611 | | m | 247 | F | .9 | .1 | m | NN | N | 7.6 | cRO | m | N | CS | U | U | 2 |
| 12 | 17:31 | 15G | 9 | 3L173 | 3700-14.0 | 06JW | 04 | 9 | m | 98 | F | .6 | .1 | 3 | NN | N | *3c | RO | .03 | N | CS | U | U | 2 |
| 13 | 17:32 | 16J | 3 | 10L167 | 3705-13.6 | 15JW | 1610 | | m | 260 | F1.2 | .2 | m | NN | N | 6.5 | cRO | m | N | CS | U | U | 2 | |
| 14 | 17:36 | 17J | 3 | 8L172 | 3695-13.9 | 16JW | 1411 | | m | 227 | F | .8 | .2 | m | NN | N | *5c | RO | m | N | CS | U | U | 2 |
| 15 | 17:39 | 18J | 2 | 5L168 | 3710-14.1 | 14JW | 1511 | | m | 236 | F | .9 | .4 | m | NN | N | 6.5 | cRO | m | N | CS | U | U | 2 |
| 16 | 17:41 | 19G | 3 | 10L169 | 3740-13.7 | 11JW | 1010 | | m | 195 | F1.8 | .0 | m | NN | N | 6.0 | cRO | m | N | CS | U | U | 2 | |
| 17 | 17:45 | 20J | 9 | 3L169 | 3700-13.3 | 08JW | 09 | 9 | m | 204 | F | .9 | 0 | 1 | NN | N | *4c | RO | .05 | N | CS | U | U | 2 |
| 18 | 17:49 | 21D | 1 | 3L170 | 3710-12.5 | 15JW | 1611 | | m | 210 | F3.6 | .013 | NN | N | *6c | RO | .10 | N | CS | U | U | 2 | | |
| 19 | 17:50 | 22A | 1 | 4L171 | 3705-12.7 | 04JW | 05 | 7 | m | 192 | F2.5 | .0 | 7 | NN | N | *2c | RO | .06 | N | CS | U | U | 2 | |
| 20 | Cloud1 | 121680cLM | UWY | Priv | Comm | 5/81 | S | 6 | St | I105-19.0 | 117 | -21 cP Hc | | | | | | | | | | 1 | | |
| 21 | 14:16 | A3D | 1 | 4L184 | 11030-20.3 | 06JW | 0410 | | m | 60 | F | .2 | 0 | U | NN | N | <1c | RO | m | N | CS | U | U | 2 |
| 22 | 14:18 | A4J | 1 | 5L183 | 11010-20.0 | 02JW | 01 | 7 | m | 44 | F | .2 | .1 | 0 | NN | N | <1c | RO | m | N | CS | U | U | 2 |
| 23 | 14:21 | A5J | 3 | 11L186 | 11565-20.9 | 05JW | 02 | 8 | m | 71 | F | .8 | .3 | <1 | NN | N | <1c | RO | m | N | CS | U | U | 2 |
| 24 | Cloud2 | 121680cLM | UWY | Priv | Comm | 5/81 | S | 6 | St | C | 40-10.7 | 58-13.6cP Hc, Wk158 | | | | | | | | | | 1 | | |
| 25 | 144942B1P | N | NP168 | 5650-13.8 | 26JW | 2515 | | | m | 134 | F1.3 | .2 | 0 | NN | N | 7.6 | cRO | .20 | N | CS | U | U | 2 | |
| 26 | 145136B2P | N | NP163 | 5165-13.2 | 27JW | 2213 | | | m | 190 | F1.8 | .3 | 1 | NN | N | 7.6 | cRO | .20 | N | CS | U | U | 2 | |
| 27 | 145312B3P | N | NP159 | 4635-11.7 | 19JW | 1712 | | | m | 188 | F1.8 | .2 | 1 | NN | N | 6.0 | cRO | .15 | N | CS | U | U | 2 | |
| 28 | 145506B4P | N | NP165 | 4155-10.7 | 03JW | 01 | 5 | | m | 174 | F1.5 | .313 | NN | N | <1c | RO | .02 | N | CS | U | U | 2 | | |
| 29 | 15:54 | D10 | 2 | 6L166 | 5500-12.7 | 34JW | 2813 | | m | 247 | F4.0 | .8 | 2 | NN | N | 7.8 | cRO | .31 | N | CS | U | U | 2 | |
| 30 | 15:56 | D2J | 3 | 9L170 | 5460-12.8 | 20JW | 1614 | | m | 117 | F1.8 | .3 | m | NN | N | 6.0 | cRO | m | N | CS | U | U | 2 | |
| 31 | 16:00 | D3J | 2 | 6L172 | 5455-12.5 | 10JW | 1415 | | m | 78 | F2.0 | .5 | m | NN | N | 7.0 | cRO | m | N | CS | U | U | 2 | |
| 32 | 16:02 | D4G | 2 | 6L176 | 5450-12.5 | 13JW | 1114 | | m | 66 | F1.8 | .4 | 5 | NN | N | 5.0 | cRO | m | N | CS | U | U | 2 | |
| 33 | 16:04 | D5G | 2 | 5L174 | 5015-11.8 | 22JW | 1913 | | m | 172 | F1.8 | .411 | NN | N | 7.2 | cRO | m | N | CS | U | U | 2 | | |
| 34 | 16:06 | D6G | 2 | 6L168 | 4915-11.4 | 28JW | 2412 | | m | 267 | F1.8 | .310 | NN | N | 8.4 | cRO | m | N | CS | U | U | 2 | | |
| 35 | 16:08 | D7E | 3 | 8L167 | 4970-11.5 | 39JW | 3512 | | m | 371 | F2.2 | .721 | NN | N | 9.0 | cRO | m | N | CS | U | U | 2 | | |
| 36 | 16:12 | D8G | 2 | 4L166 | 4445-10.6 | 22JW | 2212 | | m | 238 | F1.9 | .430 | NN | N | 6.3 | cRO | m | N | CS | U | U | 2 | | |
| 37 | 16:13 | D9E | 2 | 5L166 | 4445-10.7 | 16JW | 0612 | | m | 68 | F2.3 | .624 | NN | N | 5.3 | cRO | m | N | CS | U | U | 2 | | |
| 38 | 16:16 | 12G | 1 | 2L175 | 4025-9.8 | 07JW | 02 | 8 | m | 76 | F2.5 | .513 | NN | N | *2c | RO | .16 | N | CS | U | U | 2 | | |
| 39 | 16:17 | 13A | 3 | 13L172 | 3940-9.6 | 13JW | 09 | 9 | m | 207 | F2.2 | .4 | m | NN | N | 4.3 | cRO | m | N | CS | U | U | 2 | |
| 40 | Cloud3 | 121680cLM | UWY | Priv | Comm | 5/81 | S | 6 | St | I108-14.7 | 89-17.1cP Hc, Wk189 | | | | | | | | | | 1 | | | |
| 41 | 153124C1P | N | NP181 | 8825-17.1 | 08JW | 1210 | | | m | 199 | F | .7 | 0 | 0 | NN | N | <1c | RO | .07 | N | CS | U | U | 2 |
| 42 | 153224C2P | N | NP177 | 8230-16.3 | 03JW | 02 | 6 | | m | 182 | F2.0 | .7 | 6 | NN | N | 0 | RO | .03 | N | CS | U | U | 2 | |
| 43 | 15:36 | C4A | 3 | 9L178 | 7970-15.6 | 01JW | 02 | 8 | m | 140 | F1.4 | .3 | m | NN | N | <1c | RO | .03 | N | CS | U | U | 2 | |
| 44 | Cloud1 | 121980GLL | UWY | Priv | Comm | 5/81 | S | 50 | St | C | 75 | U | *85*-13 c WkU12FSmCf, 9-1851 | | | | | | | | | | 1 | |
| 45 | 18:34 | A1G | 4 | 12L182 | 7595-11.8 | X JW | 0513 | | m | 39 | F2.4 | .0 | m | NN | N | 4.3 | cRO | m | N | CS | U | U | 2 | |
| 46 | 18:38 | A2G | 1 | 3L174 | 7610-11.2 | 05JW | 1214 | | m | 78 | F5.6 | .0 | 50 | NN | N | 6.8 | cRO | .14 | N | CS | U | U | 2 | |
| 47 | 18:39 | A3G | 2 | 7L171 | 7595-11.2 | 15JW | 2116 | | m | 103 | F9.2 | .1 | m | NN | N | 8.4 | cRO | m | N | CS | U | U | 2 | |
| 48 | 18:41 | A4G | 1 | 3L172 | 7585-11.1 | 07JW | 0813 | | m | 69 | F1.8 | .1 | 9 | NN | N | 5.5 | cRO | m | N | CS | U | U | 2 | |
| 49 | 18:42 | A5G | 1 | 4L176 | 7600-11.4 | 13JW | 1413 | | m | 127 | F1.8 | .1 | m | NN | N | 6.5 | cRO | m | N | CS | U | U | 2 | |
| 50 | 18:44 | A6G | 1 | 3L171 | 7585-11.5 | 17JW | 1913 | | m | 175 | F | .8 | 0 | 6 | NN | N | 7.6 | cRO | .19 | N | CS | U | U | 2 |
| 51 | 18:45 | A7G | 1 | 3L170 | 7600-11.4 | 23JW | 2513 | | m | 228 | F | .3 | 0 | 2 | NN | N | 7.6 | cRO | .25 | N | CS | U | U | 2 |
| 52 | 18:46 | A8D | 2 | 5L169 | 7575-11.3 | 11JW | 1311 | | m | 159 | F3.3 | .0 | m | NN | N | 5.3 | cRO | m | N | CS | U | U | 2 | |
| 53 | 18:48 | A9D | 4 | 11L175 | 7610-11.4 | 08JW | 08 | 9 | m | 200 | F8.3 | .260 | NN | N | 5.0 | cRO | m | N | CS | U | U | 2 | | |
| 54 | 18:52 | 10G | 2 | 6L175 | 7595-11.9 | 17JW | 1913 | | m | 173 | F1.5 | .0 | m | NN | N | 7.0 | cRO | m | N | CS | U | U | 2 | |
| 55 | 18:54 | 11G | 2 | 6L172 | 7600-12.3 | 14JW | 1915 | | m | 106 | F | .6 | 0 | m | NN | N | 6.7 | cRO | m | N | CS | U | U | 2 |
| 56 | 18:56 | 12G | 1 | 4L171 | 7615-12.9 | 10JW | 1617 | | m | 69 | F1.6 | .0 | m | NN | N | 6.0 | cRO | .17 | N | CS | U | U | 2 | |
| 57 | 18:58 | 13J | 3 | 9L171 | 7615-13.0 | 06JW | 0916 | | m | 37 | F2.1 | .0 | m | NN | N | 5.0 | cRO | m | N | CS | U | U | 2 | |
| 58 | 19:03 | 14G | 1 | 4L174 | 7615-12.2 | 09JW | 0918 | | m | 25 | F1.9 | .0 | m | NN | N | 7.0 | cRO | .11 | N | CS | U | U | 2 | |
| | | 11111111112222222222333333333344444444445555555555666666666677777777778 | | | | | | | | | | | | | | | | | | | | | | |
| | | 12345678901234567890123456789012345678901234567890123456789012345678901234567890 | | | | | | | | | | | | | | | | | | | | | | |

11111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 20

| Rec. No. | | Card (Record) | | Contents | |
|----------|-----------|-----------------|--|--------------------|------------|
| 1 | Cloud2 | 121980LHX | UWY Priv Comm 5/81 S45 St C 12-10.1>86 U | a | WkUf2F5mCf |
| 2 | 19.20 15E | 3 8L165 8520 | -9.3.01JW.1215 m 74 F7.4 .1 m NN N | 6.6cRO m N | CS U U 2 |
| 3 | 19240016P | N NP178 8010 | -9.0.03JW.0814 m 61 F4.3 .120 NN N | #6 cRO.15 N | CS U U 2 |
| 4 | 19243617P | N NP182 7515 | -9.6.07JW.1112 m130 F9.4 .425 NN N | <3 cRO.18 N | CS U U 2 |
| 5 | 19250G18P | N NP179 7105 | -11.6 0 JW.01 7 m 42 F7.3 .327 NN N | <1 cRO.06 N | CS U U 2 |
| 6 | 21.22 44G | 514L177 7575 | -9.8.03JW.0410 m 61 F3.0 0 m NN N | 3.4cRO m N | CS U U 2 |
| 7 | 21.27 45E | 3 9L175 7570 | -11.2.06JW.0712 m 83 F1.5 0 m NN N | 6.0cRO.09 N | CS U U 2 |
| 8 | Cloud3 | 121980LHX | UWY Priv Comm 5/81 S40 St B 55-10.7 61-11.1a | WkUf2F5mCf | |
| 9 | 19264219P | N NP170 6035 | -11.1.06JW.05 7 m128 F1.1 .1 1 NN N | <1 cRO.02 N | CS U U 2 |
| 10 | 19.27 20A | 1 3L164 5555 | -10.3.05JW.05 9 m138 F2.1 .1 m NN N | <1 cRO.06 N | CS U U 2 |
| 11 | 19321821P | N NP158 5505 | -9.1 0 JW.01 6 m101 F.2 0 0 NN N | 0 RO 0 N | CS U U 2 |
| 12 | 19324822P | N NP154 5995 | -9.3.04JW.04 7 m224 F.1 0 0 NN N | 0 RO.01 N | CS U U 2 |
| 13 | Cloud4 | 121980LHX | UWY Priv Comm 5/81 S50 St C 11-8.1 94-11.4c | WkUf2F5mCf, Sr1941 | |
| 14 | 19344823P | N NP153 7900 | -8.5.02JW.02 7 m147 F1.4 0 7 NN N | 0 cRO.03 N | CS U U 2 |
| 15 | 19352424P | N NP158 8290 | -9.2.06JW.0911 m120 F.6 0 0 NN N | #12cRO.11 N | CS U U 2 |
| 16 | 19355425P | N NP157 8745 | -10.2.13JW.2014 m141 F2.4 0 7 NN N | #8 cRO.22 N | CS U U 2 |
| 17 | 19362426P | N NP154 9270 | -11.3.12JW.2816 m126 F1.7 0 5 NN N | #10cRO.28 N | CS U U 2 |
| 18 | 19.47 27G | 1 3L184 8590 | -10.0.07JW.1513 m122 F.4 0 1 NN N | 6.6cRO.09 N | CS U U 2 |
| 19 | 19.48 28D | 1 3L177 8540 | -10.4.07JW.1611 m193 F.1 0 0 NN N | 6 cRO m N | CS U U 2 |
| 20 | 19.52 29E | 1748L176 8460 | -11.7.09JW.0911 m116 F1.7 .1 m NN N | 4.5cRO m N | CS U U 2 |
| 21 | Cloud4a | 121980DHT | UWY Priv Comm 5/81 S38 St C 82-11.4 93-11.9a | WkUf3F5mCf, Sr1931 | |
| 22 | 20.21 30D | 3 8L190 8550 | -11.6.09JW.0611 m 97 F1.0 .1 m NN N | 2.5cRO m N | CS U U 2 |
| 23 | 20.23 31E | 514L184 8535 | -11.1.03JW.0510 m 91 F1.4 .3 m NN N | 3.5cRO m N | CS U U 2 |
| 24 | 20353033P | N NP208 9330 | -10.9.14JW.1112 m113 F1.7 .1 2 NN N | #7 cRO.14 N | CS U U 2 |
| 25 | 20361834P | N NP201 9030 | -10.4.06JW.0612 m 81 F2.7 .113 NN N | #6 cRO.07 N | CS U U 2 |
| 26 | 20.38 35E | 411L182 8505 | -10.5 0 JW.0410 m 78 F1.4 .2 m NN N | 1.3cRO m N | CS U U 2 |
| 27 | 20.53 40D | 1337L175 8525 | -9.6.01JW.0913 m 67 F4.9 0 m NN N | 5.0cRO m N | CS U U 2 |
| 28 | Cloud5 | 121980AKO | UWY Priv Comm 5/81 S44 St B 62-10.3 80-11.8a | WkUf2F5mCf, Sr1801 | |
| 29 | 21414247P | N NP166 7100 | -10.6.01JW.01 8 m 67 F 0 0 0 NN N | 0 cRO.01 N | CS- U 2 |
| 30 | 21422448P | N NP168 7605 | -11.5.03JW.0510 m 82 F.3 0 0 NN N | U RO.03 N | CS- U 2 |
| 31 | 21425449P | N NP171 7930 | -11.9.05JW.0713 m 54 F.2 0 0 NN N | U RO.07 N | CS- U 2 |
| 32 | Cloud6 | 121980AKO | UWY Priv Comm 5/81 S50 St C 62-13.3 79-12.8a | WkUf2F5mCf, Sr1791 | |
| 33 | 21464850P | N NP202 7880 | -12.8.18JW.2215 m138 F.8 0 1 NN N | #14cRO.17 N | CS U U 2 |
| 34 | 21.47 51G | 51G133L179 7580 | -12.0.10JW.1717 m123 F3.9 .1 m NN N | 7.0cRO m N | CS U U 2 |
| 35 | 21.59 52A | 618L172 7635 | -13.2.03JW.0814 m 63 F4.1 0 m NN N | 5.6cRO m N | CS U U 2 |
| 36 | Cloud7 | 121980CYS | UWY Priv Comm 5/81 S58 St C 62-13.3 73-14.8a | WkUf2F5mCf, Sr1731 | |
| 37 | 22.07 53E | 4 9L158 7265 | -13.6 0 JW.0412 m 47 F2.0 0 m NN N | 3.8cRO m N | CS U U 2 |
| 38 | 22140056P | N NP162 6280 | -13.0.03JW.03 7 m167 F2.0 .626 NN N | U cRO 0 N | CS- U 2 |
| 39 | 22142457P | N NP156 6840 | -14.2.11JW.1311 m188 F2.6 .529 NN N | #6 cRO.05 N | CS- U 2 |
| 40 | 22150058P | N NP165 7240 | | | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 21

| Rec. No. | | Card (Record) Contents | | Card Column No. | |
|----------|-----------|------------------------|--------------------|----------------------|---|
| 1 | Cloud1 | 010781cLM | UWY Priv Comm 5/81 | 5 | 6 St C 36-18.5 55-23.3cA U, Wk155 |
| 2 | 14.02 | A1G | 1 3L182 | 3975-19.4.11JW.0810 | m103 F8.43.6 m NN N #4 cRO m N CSS U 2 |
| 3 | 14.03 | A2D | 2 5L173 | 4010-19.5.11JW.0810 | m139 F5.72.9 m NN N 4 cRO m N CSS U 2 |
| 4 | 14.05 | A3E | 1 3L165 | 4045-19.9.06JW.06 9 | m128 F7.63.6 m NN N 3 cRO m N CSS U 2 |
| 5 | 140754A5P | N | NP155 | 4450-20.8.10JW.1312 | m136 F18.5.413 NN N #4 cRO.09 N CSS U 2 |
| 6 | 140830A6P | N | NP154 | 5025-22.2.15JW.1914 | m141 F9.33.4 2 NN N #4 cRO.14 N CSS U 2 |
| 7 | 140854A7P | N | NP152 | 5420-23.1.18JW.1814 | m119 F2.5.6 0 NN N #4 cRO.14 N CSS- U 2 |
| 8 | 14.15 | B1E | 2 4L171 | 5240-23.1.17JW.1514 | m108 F2.2.8 m NN N 3 cRO m N CSS- U 2 |
| 9 | 14.17 | B2G | 7 17L159 | 5025-21.8.13JW.1413m | 120 F6.42.7 m NN N X RO m N CSS U 2 |
| 10 | 14.24 | B3H | 720L160 | 5010-21.6.10JW.1212 | m123 F11 3.8 m NN N X RO m N CSS U 2 |
| 11 | 14.31 | B4J | 2 5L159 | 4980-22.1.08JW.1110 | m198 F25.5.9 m NN N X RO m N CSS U 2 |
| 12 | 14.33 | B5J | 2 6L162 | 5055-22.4.12JW.1311 | m222 F35.7.4 m NN N #4 c m m N CSS U 2 |
| 13 | 14.36 | B6J | 7 2L163 | 5020-22.0.24JW.2211 | m287 F43 8.589 NN N X RO m N CSS U 2 |
| 14 | 14.38 | B7J | 6 2L164 | 5055-22.4.12JW.1311 | m176 F28 5.439 NN N X RO.13 N CSS U 2 |
| 15 | 14.39 | B8A | 718L161 | 5015-22.4.13JW.1212 | m112 F18 4.8 m NN N X RO m N CSS U 2 |
| 16 | Cloud2 | 010781cLM | UWY Priv Comm 5/81 | 5 | 6 Sc B U 29-20.6cA U |
| 17 | 15.47 | C1J | 6 2L157 | 2835-20.3.07JW.06 7 | m384 F2.81.3 7 NN N U RO.04 N CSS- U 2 |
| 18 | 16.14 | C2A | 6 1L145 | 2825-15.6.04JW.01 7 | m267 F12 3.627 NN N 0 RO.03 N CSS U 2 |
| 19 | Cloud4 | 010781cLM | UWY Priv Comm 5/81 | 5 | 6 St V U U 43-22.5cA U, pC10 |
| 20 | 16.30 | D1G | 412L175 | 3830-20.3.08JW.07 7 | m301 F16 4.4 m NN N #3 cRO m N CSS U 2 |
| 21 | 16.34 | D2A | 620L168 | 3885-20.7.10JW.09 7 | m390 F8.02.6 m NN N #2 c m N N CSS U 2 |
| 22 | Cloud5 | 010781cLM | UWY Priv Comm 5/81 | 5 | 6 Sc B U U U cA U |
| 23 | 16.44 | E1J | 5 2L192 | 4520-22.5.13JW.11 9 | m312 F2.4.8 6 NN N U RO.10 N CSS- U 2 |
| 24 | 16.45 | E2J | 5 2L190 | 4520-22.2.07JW.08 9 | m213 F2.6.8 5 NN N U RO.06 N CSS- U 2 |
| 25 | 16.47 | E3J | 1 3L187 | 4505-22.1.18JW.15 9 | m364 F6.41.516 NN N X RO.12 N CSS- U 2 |
| 26 | 16.49 | E4J | 7 2L183 | 4520-21.7.08JW.10 9 | m264 F4.9 0 8 NN N X RO.04 N CS U U 2 |
| 27 | 16.52 | E5J | 7 2L180 | 4515-21.4.07JW.09 9 | m237 F11 0 22 NN N X RO.06 N CS U U 2 |
| 28 | 16.53 | E6J | 1 3L178 | 4520-21.3.09JW.10 9 | m261 F17 0 30 NN N X RO m N CS U U 2 |
| 29 | 16.59 | E7A | 6 2L172 | 4510-20.1.07JW.08 9 | m203 F24 0 82 NN N U RO.06 N CS U U 2 |
| 30 | 17.04 | F1D | 1 5L227 | 5780-25.0.03JW.03 8 | m 89 F4.4 0 9 NN N U RO m N CS U U 2 |
| 31 | 17.05 | F2A | 1 5L228 | 5860-24.6.11JW.1111 | m154 F19 0 26 NN N U RO m N CS U U 2 |
| 32 | CloudA | 010881cLM | UWY Priv Comm 5/81 | 5 | 6 Sc B 44-17.0 64-21.3cA U, 164 |
| 33 | 133806A1P | N | NP164 | 4430-17.0.06JW.07 8 | m297 F2.51.4 0 NN N X RO.03 N CSS- U 2 |
| 34 | 133900A2P | N | NP159 | 4945-18.1.04JW.08 9 | m183 F1.91.0 0 NN N X RO.04 N CSS- U 2 |
| 35 | 133948A3P | N | NP161 | 5450-19.0.06JW.07 9 | m186 F18 4.4 9 NN N X RO.06 N CSS U 2 |
| 36 | 134048A4P | N | NP159 | 5965-20.3.26JW.2511 | m319 F2.21.2 1 NN N X RO.19 N CSS- U 2 |
| 37 | 134124A5P | N | NP159 | 6380-21.3.42JW.3412 | m350 F1.1.2 1 NN N X RO.35 N CS U U 2 |
| 38 | 13.57 | A6J | 5 2L176 | 6335-20.9.14JW.1410 | m188 F.8.1<1 NN N U RO.09 N CS U U 2 |
| 39 | 14.00 | A7J | 1 3L164 | 6290-21.2.25JW.2210 | m370 F1.9.6 3 NN N X RO.20 N CSS- U 2 |
| 40 | 14.02 | A8E | 5 13L163 | 6280-20.9.35JW.2911 | m418 F4.01.7 m NN N X RO m N CSS- U 2 |
| 41 | 14.06 | A9D | 719L161 | 5830-19.7.30JW.2811 | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 22

| -----Card Column No.----- | |
|---|--|
| 11111111111222222222233333333334444444445555555555666666666677777777778 | |
| 1234567890123456789012345678901234567890123456789012345678901234567890 | |
| Rec. No. | Card (Record) Contents |
| 1 | CloudC 010881cLM UMY Priv Comm 5/81 S 6 Sc 1 48-16.6>58 U cA U,pC1LO 1 |
| 2 | 155906C1P N NP164 5040-17.3.18JW.13 9 m344 F62 12 51 NN N X RO.17 N CSS+ U 2 |
| 3 | 155930C2P N NP153 5580-18.5.21JW.2510 m480 F20 5.230 NN N X RO.20 N CSS U 2 |
| 4 | 1559 C3A 1 4L169 5810-19.2.22JW.1610 m303 F15 3.9 m NN N X RO m N CSS U 2 |
| 5 | Cloud1 011181cLM UMY Priv Comm 5/81 S 6 St 1 20-18.1>36 U cA U,Wk158,pC1LO 1 |
| 6 | 14:17 A1G 1 3L169 3540-19.4.11JW.08 7 m419 F12 4.0m5 NN N #6 cRO m N CSS- U 2 |
| 7 | 14:18 A2G 1 4L167 3535-19.8.08JW.07 7 m316 F9.22.4m5 NN N #6 cRO m N CSS U 2 |
| 8 | 14:20 A3J 1 3L165 3525-19.9.11JW.09 / m405 F7.42.2 m NN N X RO m N CSS U 2 |
| 9 | 142606B1P N NP175 2870-19.2.06JW.04 6 m313 F .3 0 1 NN N 0 RO.02 N CS U 2 |
| 10 | 142718B2P N NP175 2110-18.1.0 JW.01 5 m124 F .6 0 0 NN N 0 RO 0 N CS U 2 |
| 11 | Cloud2 011181cLM UMY Priv Comm 5/81 S 6 St 1 24m-18 36 #19 cA U,pC1LO 1 |
| 12 | 16:10 C1G 6 2L158 3510-19.4.06JW.05 / m213 F14 4.1 9 NN N U RO m N CSS U 2 |
| 13 | 16:13 C2J 8 2L153 3555-18.8.06JW.05 / m293 F6.52.5 5 NN N U RO m N CSS U 2 |
| 14 | 16:16 C3J 1 3L156 3560-18.3.06JW.05 8 m152 F20 6.8 8 NN N U RO m N CSS U 2 |
| 15 | 16:31 C4J 9 2L154 3560-17.9.12JW.1010 m166 F16 5.3 8 NN N U RO m N CSS U 2 |
| 16 | 16:37 C6J 5 1L165 3655-18.4.15JW.1312 m180 F15 4.810 NN N U RO m N CSS U 2 |
| 17 | Cloud3 011181cLM UMY Priv Comm 5/81 S 6 St 1 41-19.3m60 U cA U 1 |
| 18 | 16:43 D1J 1 3L165 4150-19.4.06JW.0711 m110 F26 9.013 NN N #4 cRO m N CSS+ U 2 |
| 19 | 16:46 D2J 5 1L167 4125-19.2.15JW.1511 m169 F18 6.6 8 NN N U RO m N CSS U 2 |
| 20 | 16:57 D3J 7 2L165 4545-20.2.09JW.0911 m100 F18 6.8 8 NN N U RO m N CSS U 2 |
| 21 | 16:59 D5J 2 5L170 4555-20.6.12JW.0910 m142 F18 5.8 m NN N X RO m N CSS U 2 |
| 22 | 17:07 D6J 6 2L161 4545-19.9.16JW.1512 m150 F20 6.611 NN N #7 cRO m N CSS U 2 |
| 23 | 17:09 D7J 8 2L158 4530-20.0.12JW.1011 m124 F25 7.813 NN N X RO m N CSS U 2 |
| 24 | 17:12 D8J 9 2L158 4580-20.1.22JW.1712 m173 F24 7.214 NN N #6 cRO m N CSS U 2 |
| 25 | 17:17 10J 6 1L145 4500-20.1.15JW.1011 m131 F11 4.2 8 NN N U RO m N CSS U 2 |
| 26 | Cloud1 011281cLM UMY Priv Comm 5/81 S 6 St 1 17 -8.8 36-11.0cP Le, logSIGMET, 1351 |
| 27 | 200330A1P N NP190 3400-12.2.32JW.27 9 m635 F .1 0 0 NN N #8 cRO.21 N CS U 2 |
| 28 | 20:04 A3J 616L165 2915-12.0.18JW.17 8 m692 F .1 0 0 NN N 6.8cRO m N CS U 2 |
| 29 | 204736D1P N NP149 1870 -9.2.02JW.05 7 m278 F 0 0 0 NN N 0 cRO.01 N CS U 2 |
| 30 | 204806D2P N NP154 2475-10.5.16JW.15 / m678 F 0 0 0 NN N #5 cRO.12 N CS U 2 |
| 31 | 20:48 U4E1028L164 2960-11.0.31JW.21 9 m647 F1.0 .3 m NN N 7.5cRO m N CS U 2 |
| 32 | Cloud1a011281cLM UMY Priv Comm 5/81 S 6 Sc 1 17 -8.8 30-11.0cP Le, Sr130 1 |
| 33 | 20:10 B1J 7 2L161 2975-11.0.12JW.08 6 m350 F .1 0 0 NN N #3 cRO.10 N CS U 2 |
| 34 | 20:11 B2J 9 2L161 2965-10.5.07JW.07 8 m247 F 0 0 0 NN N #4 cRO m N CS U 2 |
| 35 | 20:39 C1J 2 5L173 2940-10.7.17JW.12 9 m353 F .1 0 0 NN N 6.5cRO m N CS U 2 |
| 36 | 20:42 C2J 9 2L163 2945-10.9.15JW.10 8 m422 F 0 0 0 NN N #6 cRO.10 N CS U 2 |
| 37 | 20:43 C3E 8 2L162 2930-10.8.13JW.09 8 m347 F .1 0 0 NN N #3 cRO m N CS U 2 |
| 38 | 204506C4P N NP156 2400-10.7.18JW.14 7 m736 F .2 0 0 NN N U cRO.11 N CS U 2 |
| 39 | 204542C5P N NP163 1770 -9.3.02JW.05 6 m466 F 0 0 0 NN N U cRO.03 N CS U 2 |
| 40 | Cloud1b011281MK0 UMY Priv Comm 5/81 S 6 St 1 14 -7.5m40 U cP Le, log SIGMET 1 |
| 41 | 20:58 D5G 9 2L163 2585 -9.9.17JW.15 9 m337 F3.11.038 NN N 6.0cRO.13 N CSS- U 2 |
| 42 | 20:58 D6E 411L159 2555 -9.7.24JW.2310 m503 F11 1.7 m NN N 7.5cRO m N CSS- U 2 |
| 43 | 210412D7P N NP162 1915 -8.5.17JW.09 8 m405 F2.0 .332 NN N U cRO.17 N CSS- U 2 |
| 44 | 210436D8P N NP167 1425 -7.5.06JW.03 5 m384 F1.0 .2 3 NN N U cRO.06 N CS U 2 |
| 45 | Cloud2b011281LAN UMY Priv Comm 5/81 S 8 St 1 22-12.9 63-12.9cP Le,Wk122,Wk163 1 |
| 46 | 21:26 04H 615L153 2900-10.4.18JW.1913 m176 F15 .2 m NN N 7.3cRO m N CS U 2 |
| 47 | 21:31 05E 2 7L163 2920-10.6.13JW.1511 m207 F2.0 .1 m NN N 5.5cRO m N CS U 2 |
| 48 | 21344206P N NP169 2445-11.3.08JW.07 8 m254 F4.4 .344 NN N <1cRO.11 N CS U 2 |
| 49 | 214136H1P N NP151 2230-12.9.02JW.04 4 m112 F1.8 .2 8 NN N U cRO 0 N CS U 2 |
| 50 | 214154H2P N NP151 2705-10.4.19JW.2013 m182 F1.8 .114 NN N #3 cRO.18 N CS U 2 |
| 51 | 214236H3P N NP161 3240-11.0.10JW.09 9 m242 F1.7 .1 2 NN N #3 cRO.07 N CS U 2 |
| 52 | 214308H4P N NP155 3780-11.8.11JW.08 8 m336 F2.6 .1 8 NN N #3 cRO.06 N CS U 2 |
| 53 | 214336H5P N NP159 4230-11.7.10JW.1011 m135 F1.4 .1 7 NN N #3 cRO.06 N CS U 2 |
| 54 | 214412H6P N NP164 4780-12.0.14JW.1516 m 70 F2.8 .120 NN N #7 cRO.13 N CS U 2 |
| 55 | 214442H7P N NP162 5205-12.1.20JW.2617 m 95 F8.5 .251 NN N #10cRO.21 N CS U 2 |
| 56 | 214512H8P N NP167 5480-12.7.26JW.3018 m 97 F17 0 93 NN N #15cRO.28 N CS U 2 |
| 57 | 214536H9P N NP148 6090-12.5.07JW.0717 m 31 F28 0 99 NN N #3 cRO.15 N CS U 2 |
| 11111111111222222222233333333334444444445555555555666666666677777777778 | |
| 1234567890123456789012345678901234567890123456789012345678901234567890 | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 23

| Rec. No. | | Card (Record) | | Contents | |
|----------|---------------------------------------|----------------|--------------------------|----------|-----|
| 1 | Cloud1c011281MKG UMY Priv Comm 5/81 S | 65tScB 17 -7.7 | 47-13.8cP Le, Sr145 | 1 | |
| 2 | 210636E1P N NP150 1695 -7.7.03JW.03 6 | m271 F1.2 .2 6 | NN N U cRO.01 N | CS U | U 2 |
| 3 | 210712E2P N NP152 2375 -9.0.08JW.06 8 | m248 F2.41.728 | NN N m<1cRO.06 N | CS- | U 2 |
| 4 | 210738E3P N NP151 2940-10.4.17JW.16 9 | m435 F1.81.122 | NN N m7 cRO.13 N | CS- | U 2 |
| 5 | 210800E4P N NP156 3405-11.3.34JW.2410 | m525 F3.3 .921 | NN N m7 cRO.24 N | CS- | U 2 |
| 6 | 210824E5P N NP156 3905-12.2.43JW.3010 | m589 F5.12.151 | NN N m10cRO.32 N | CS- | U 2 |
| 7 | 210854E6P N NP159 4420-13.3.62JW.3811 | m599 F1.2 .2 0 | NN N m10cRO.45 N | CS U | U 2 |
| 8 | 211248F1P N NP177 4715-13.8.58JW.3712 | m407 F2.7 .317 | NN N m15cRO.41 N | CS U | U 2 |
| 9 | 211318F2P N NP173 4155-13.0.39JW.2911 | m386 F44 2.550 | NN N X cRO.28 N | CS- | U 2 |
| 10 | 211342F3P N NP170 3715-12.1.30JW.2211 | m343 F14 1.484 | NN N X RO.23 N | CS- | U 2 |
| 11 | 211412F4P N NP166 3210-11.1.18JW.1410 | m256 F7.91.459 | NN N X RO.13 N | CS- | U 2 |
| 12 | 21.14 F6J.7 2L154 2880-10.4.05JW.05 9 | m117 F10 1.6 m | NN N U RO m N | CS- | U 2 |
| 13 | 21.16 F7A 1 3L149 2885-10.2.12JW.1310 | m249 F30 1.499 | NN N m6 cRO m N | CS- | U 2 |
| 14 | 21.59 14D 1 4L169 4030-12.6.07JW.05 9 | m126 F4.11.0 m | NN N m3 cRO m N | CS- | U 2 |
| 15 | 22.00 15O 2 6L162 3950-12.4.15JW.1511 | m224 F5.41.3 m | NN N 6.0cRO m N | CS- | U 2 |
| 16 | 22.02 16E 512L164 3985-12.4.22JW.2011 | m298 F6.51.8 m | NN N 8.0cRO m N | CS- | U 2 |
| 17 | 22074817P N NP170 3410-11.3.31JW.2711 | m386 F3.51.233 | NN N m7 cRO.30 N | CS- | U 2 |
| 18 | 22081218P N NP167 2875-10.6.24JW.2011 | m299 F2.2 .639 | NN N m6 cRO.22 N | CS- | U 2 |
| 19 | 22.08 10E 2 5L142 2530 -9.8.24JW.1910 | m354 F1.3 .2 m | NN N 7.0cRO m N | CS U | U 2 |
| 20 | 22112411P N NP151 1820 -8.3.08JW.04 7 | m269 F.9.2 7 | NN N <1 cRO.04 N | CS U | U 2 |
| 21 | Cloud2m011281LAN UMY Priv Comm 5/81 S | 8 St CM20 U | 55-11.2cP Le, 155, wk145 | 1 | |
| 22 | 21.23 G1D.7 2L159 2935-10.1.04JW.05 7 | m213 F11 .299 | NN N m6 cRO.08 N | CS U | U 2 |
| 23 | 21.24 G2O.6 2L158 2925-10.2.10JW.0910 | m182 F31 .399 | NN N 6.0cRO.16 N | CS U | U 2 |
| 24 | 21.25 G3O.9 2L156 2925-10.3.08JW.0811 | m108 F33 .299 | NN N m6 cRO.13 N | CS U | U 2 |
| 25 | 21560011P N NP160 5450-11.2.06JW.0817 | m 31 F1.1 0 0 | NN N m4 cRO.09 N | CS U | U 2 |
| 26 | 21563012P N NP164 4970-11.5.05JW.0918 | m 29 F 1.0 0 0 | NN N m4 cRO.10 N | CS U | U 2 |
| 27 | 21570013P N NP164 4455-13.0.10JW.1013 | m 96 F1.0 0 0 | NN N m4 cRO.13 N | CS U | U 2 |
| 28 | Cloud1 011481MKG UMY Priv Comm 5/81 S | 65tScB 48-10.4 | 65-13.0cP U, 165 | 1 | |
| 29 | 203736A1P N NP148 4845-10.5.0 JW.01 5 | m 87 F2.2 .4 4 | NN N 0 cRO 0 N | CS U | U 2 |
| 30 | 203806A2P N NP159 5370-11.4.11JW.0912 | m106 F2.1 .3 6 | NN N m6 cRO.10 N | CS U | U 2 |
| 31 | 203830A3P N NP158 5910-12.4.18JW.1815 | m 80 F1.6 .3 0 | NN N m6 cRO.15 N | CS U | U 2 |
| 32 | 203848A4P N NP155 6260-13.2.18JW.1915 | m102 F1.4 .1 0 | NN N U cRO.18 N | CS U | U 2 |
| 33 | Cloud2 011481MKG UMY Priv Comm 5/81 S | 6 St C 38 -8.6 | 65-12.2cP U, 165 | 1 | |
| 34 | 213142B1P N NP153 6420-13.3.24JW.2213 | m201 F1.9 .3 0 | NN N m9 cRO.23 N | CS U | U 2 |
| 35 | 213238B2P N NP154 5940-12.7.16JW.1812 | m174 F3.3 .511 | NN N m7 cRO.17 N | CS U | U 2 |
| 36 | 213324B3P N NP146 5470-11.7.16JW.1311 | m220 F2.2 .5 5 | NN N m6 cRO.14 N | CS U | U 2 |
| 37 | 213424B4P N NP151 4960-11.1.13JW.1210 | m257 F3.1 .516 | NN N m5 cRO.11 N | CS U | U 2 |
| 38 | 213524B5P N NP151 4455-10.0.09JW.07 8 | m229 F3.3 .613 | NN N m3 cRO.03 N | CS U | U 2 |
| 39 | 213642B6P N NP149 3950 -9.1.02JW.01 5 | m169 F2.5 .4 9 | NN N U cRO 0 N | CS U | U 2 |
| 40 | 21.40 C6D 412L165 6085-13.1.22J | | | | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 24

[illegible]

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 25

| Card Column No. | |
|---|--|
| 1111111111122222222222333333333344444444445555555555666666666677777777778 | |
| 1234567890123456789012345678901234567890123456789012345678901234567890 | |
| Rec. No. | Card (Record) Contents |
| 1 | Cloud3 0130810DC UMY Priv Comm 55/815245t8eC 25 -5.6 45 -8.4eP Hp, Sr145 1 |
| 2 | 19164213P N NP158 4535 -8.4.18JW.2112 m218 FJ.4 .253 NN N M9 aRO X N CS U U 2 |
| 3 | 19171814P N NP163 4030 -8.1.31JW.2812 m28J F11 0 99 NN N M9 aRO X N CS U U 2 |
| 4 | 191715E 3 7L151 3740 -7.4.20JW.2412 m258 F9.1 0 m NN N 8.2aRO X N CS U U 2 |
| 5 | 19204817P N NP157 3190 -6.8.22JW.1910 m405 F8.8 .186 NN N 7.5aRO X N CS U U 2 |
| 6 | 1912118E.8 2L147 2620 -5.7.05JW.07 7 m322 F11 .2 m NN N M3 aRO X N CS U U 2 |
| 7 | 19225418P N NP138 3190 -6.8.17JW.2010 m343 F14 .198 NN N M7 aRO X N CS U U 2 |
| 8 | 19231820P N NP142 3620 -7.3.21JW.2612 m321 F12 0 99 NN N M7 aRO X N CS U U 2 |
| 9 | 19235421P N NP150 4115 -7.5.12JW.2215 m138 F12 0 99 NN N M10aRO X N CS U U 2 |
| 10 | 19242422P N NP154 4365 -7.8.18JW.1812 m176 F7.4 0 68 NN N U aRO X N CS U U 2 |
| 11 | Cloud4 013081wKS UMY Priv Comm 5/81 5245t8eC m26m-5.7m47m-8.5eP Hp, Sr147 1 |
| 12 | 19130 E18.5 1L169 4690 -7.4.17JW.1512 m142 F .2 .2 0 NN N M8 aRO X N CS U U 2 |
| 13 | 19132 E2B 2 3L171 4650 -8.3.20JW.1812 m167 F4.0 0 19 NN N M7 aRO X N CS U U 2 |
| 14 | 19134 E3D 2 4L167 4645 -7.5.12JW.1111 m147 F .7 0 m NN N 4.5aRO X N CS U U 2 |
| 15 | 19136 E4J 411L160 4640 -8.4.20JW.1812 m176 F11 0 m NN N 8.5aRO X N CS U U 2 |
| 16 | 19141 E5J 513L156 4650 -8.5.22JW.1111 m169 F11 0 99 NN N 9.0aRO X N CS U U 2 |
| 17 | 19148 E6A1129L159 4645 -8.8.19JW.0910 m178 F11 0 m NN N 5.5aRO X N CS U U 2 |
| 18 | Cloud5 013081MCK UMY Priv Comm 5/81 524 51 0 29 -8.7 53-10.5eP Hp, Sr153 1 |
| 19 | 202048F1P N NP185 5315 -9.1.23JW.1915 m103 FJ.3 .228 NN N M7 aRO X N CS U U 2 |
| 20 | 202124F2P N NP178 4800 -11.2.17JW.1214 m 88 F14 .199 NN N M8 aRO X N CS U U 2 |
| 21 | 202154F3P N NP175 4300 -9.2.16JW.0912 m108 F15 .199 NN N M8 aRO X N CS U U 2 |
| 22 | 20122 F4E 2 4L156 3850 -9.7.11JW.10 8 m250 F11 .199 NN N 5.5aRO X N CS U U 2 |
| 23 | 202506F5P N NP163 3325 -9.2.05JW.03 7 m13/ F9.2 .179 NN N <1 aRO X N CS U U 2 |
| 24 | 202542F6P N NP161 3005 -8.7.03JW.02 8 m230 FJ.5 .222 NN N <1 aRO X N CS U U 2 |
| 25 | 20300601P N NP151 3110 -9.1.04JW.02 7 m155 F11 .593 NN N M6 aRO X N CS U U 2 |
| 26 | 20302402P N NP147 3610 -10.1.10JW.10 9 m320 F13 .299 NN N M6 aRO X N CS U U 2 |
| 27 | 20310003P N NP155 4125 -9.4.05JW.0912 m107 F9.1 .188 NN N M6 aRO X N CS U U 2 |
| 28 | 20132 04A1429L157 4810 -9.9.18JW.1915 m108 F12 0 99 NN N 8.5aRO X N CS U U 2 |
| 29 | Cloud1 013181LBF UMY Priv Comm 5/81 528 5a 51 -8.3 64-11.2eP U, CILLO 1 |
| 30 | 18113 A6E 513L166 6200 -10.9.14JW.1612 m165 F2.0 .3 m NN N 7.2aRO m N CS UmW+12 |
| 31 | 181848A7P N NP179 5625 -9.5.11JW.0911 m121 F5.3 .738 NN N M7 aRO.10 N CS5-mW+12 |
| 32 | 182006A6P N NP174 5110 -8.3.09JW.04 9 m 95 F6.2 .853 NN N U aRO.05 N CS5-mW+12 |
| 33 | 182824B1P N NP144 5205 -8.8 0 JW.02 6 m176 F2.3 .6 4 NN N 0 aRO 0 N CS UmW+12 |
| 34 | 182848B2P N NP151 5765 -9.9.04JW.06 7 m314 F1.0 .2 9 NN N <1aRO.05 N CS UmW 2 |
| 35 | 182906B3P N NP148 6235 -10.8.22JW.2111 m305 F1.3 .3 6 NN N U aRO.22 N CS UmW 2 |
| 36 | Cloud2 013181LBF UMY Priv Comm 5/81 528 51 V 75-11.0 90 -8.2eP U, CILOWk175 1 |
| 37 | 183000C1P N NP152 7500 -11.0.01JW.03 7 m 76 F2.1 .747 NN N <1aRO.02 N CS5- W+12 |
| 38 | 183038C2P N NP159 8125 -10.2.02JW.02 9 m 58 F2.1 .819 NN N <1aRO.03 N CS5- W+12 |
| 39 | 183054C3P N NP151 8540 -9.6.04JW.05 9 m119 F2.61.236 NN N <1aRO.04 N CS5- W+12 |
| 40 | 183118C4P N NP156 8900 -9.4.04JW.05 9 m165 F1.8 .717 NN N <1aRO.05 N CS5-mW+12 |
| 41 | Cloud3 013181LBF UMY Priv Comm 5/81 528 51 V110 -9.7129-13.3eP U, ThCILLO 1 |
| 42 | 183312D1P N NP16511050 -9.7.02JW.03 5 m167 F1.8 .8 9 NN N <1aRO.02 N CS5-mW 2 |
| 43 | 183336D2P N NP16611540 -10.8.10JW.10 9 m278 F2.4 .7 8 NN N U aRO.11 N CS5-mW+12 |
| 44 | 183406D3P N NP17012035 -11.6.10JW.11 9 m280 F2.7 .817 NN N M6 aRO.12 N CS5-mW+12 |
| 45 | 183430D4P N NP16312560 -12.6.13JW.1410 m254 F2.0 .926 NN N U aRO.18 N CS5-mW+12 |
| 46 | 183454D5P N NP17012940 -13.3.04JW.05 9 m 81 F1.4 .313 NN N <1aRO.03 N CS U W+12 |
| 47 | Cloud4 013181LBF UMY Priv Comm 5/81 528 51 I144-16.7150-17.8eP U, nol>100 1 |
| 48 | 183624E1P N NP17314430 -17.3.01JW.01 6 m152 F4.01.415 NN N M0 aRO 0 N CS5-W?152 |
| 49 | 183654E2P N NP17214930 -17.6.02JW.02 6 m247 F2.5 0 4 NN N M0 aRO 0 N CS OW+12 |
| 50 | Cloud5 0131810DR UMY Priv Comm 5/81 533 5a 0 U U U aP U, mCILLO 1 |
| 51 | 19143 G10.7 2L177 6105 -11.4.02JW.01 7 m 59 F8.61.224 NN N <1aRO.02 N CS5-m1+32 |
| 52 | 19144 G2D 411L174 6295 -12.0.05JW.05 9 m145 F4.1 .5 m NN N 3.0aRO m N CS UmW+12 |
| 53 | 19147 G3D 2 6L178 6355 -12.0.13JW.1110 m219 F2.7 .3m7 NN N 5.0aRO m N CS UmW+12 |
| 54 | 19149 G4A 3 7L172 6310 -11.8.03JW.03 7 m173 F2.9 .4m8 NN N M2 aRO m N CS UmW+12 |
| 55 | Cloud6 013181SNY UMY Priv Comm 5/81 542 51 I U U U aP U 1 |
| 56 | 17148 A1J.9 3L169 6170 -10.5.11JW.10 9 m225 F1.8 .4 m NN N U RO m N CS UmW+12 |
| 57 | 17151 A2J 2 4L172 6175 -10.3.08JW.10 9 m234 F1.8 .3 m NN N M2 aRO m N CS UmW+12 |
| 1111111111122222222222333333333344444444445555555555666666666677777777778 | |
| 1234567890123456789012345678901234567890123456789012345678901234567890 | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 26

[illegible]

Note: On type "2" records for U. Wyo. Sierra Co-op data (Files 26-31), columns 38-37 contain approximate MVDs estimated from $MVD = \text{mean dia.} \cdot 100 \times (\text{cube root of } 6 \times LWC / (\pi \times \text{conc})).$

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 27

| Card Column No. | | Card (Record) | | Contents | | Card Column No. | | Card (Record) | | Contents | | Card Column No. | | Card (Record) | | Contents | | | | |
|-----------------|--|--|-----------|--|--|-----------------|--|--|-----------|--|--|-----------------|--|--|-----------|--|--|---|--|--|
| 1 | 1111111111222222222233333333334444444444555555555566666666667777777777 | 1234567890123456789012345678901234567890123456789012345678901234567890 | 1 | 1111111111222222222233333333334444444444555555555566666666667777777777 | 1234567890123456789012345678901234567890123456789012345678901234567890 | 1 | 1111111111222222222233333333334444444444555555555566666666667777777777 | 1234567890123456789012345678901234567890123456789012345678901234567890 | 1 | 1111111111222222222233333333334444444444555555555566666666667777777777 | 1234567890123456789012345678901234567890123456789012345678901234567890 | 1 | 1111111111222222222233333333334444444444555555555566666666667777777777 | 1234567890123456789012345678901234567890123456789012345678901234567890 | 1 | 1111111111222222222233333333334444444444555555555566666666667777777777 | 1234567890123456789012345678901234567890123456789012345678901234567890 | 1 | 1111111111222222222233333333334444444444555555555566666666667777777777 | 1234567890123456789012345678901234567890123456789012345678901234567890 |
| Rec. | No. | Card (Record) | Contents | Card (Record) | Contents | Card (Record) | Contents | Card (Record) | Contents | Card (Record) | Contents | Card (Record) | Contents | Card (Record) | Contents | Card (Record) | Contents | | | |
| 1 | 17:29Z 90.4 1L175 7900 | -8.8.58JW.019 m272 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | | | |
| 2 | 17:30 100.5 1L169 7900 | -8.8.14JW.3019 m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | m 90 F m | | | |
| 3 | 17:30 110.4 1L169 8000 | -8.8.54JW.116 m496 F m | m 496 F m | m 496 F m | m 496 F m | m 496 F m | m 496 F m | m 496 F m | m 496 F m | m 496 F m | m 496 F m | m 496 F m | m 496 F m | m 496 F m | m 496 F m | m 496 F m | m 496 F m | | | |
| 4 | 17:31 120.3 1L169 7900 | -8.9.40JW.6315 m337 F m | m 337 F m | m 337 F m | m 337 F m | m 337 F m | m 337 F m | m 337 F m | m 337 F m | m 337 F m | m 337 F m | m 337 F m | m 337 F m | m 337 F m | m 337 F m | m 337 F m | m 337 F m | | | |
| 5 | 17:32 150.7 2L161 7900 | -8.4.31JW.4418 m149 F m | m 149 F m | m 149 F m | m 149 F m | m 149 F m | m 149 F m | m 149 F m | m 149 F m | m 149 F m | m 149 F m | m 149 F m | m 149 F m | m 149 F m | m 149 F m | m 149 F m | m 149 F m | | | |
| 6 | 17:33 16A.4 1L163 7900 | -8.4.44JW.5620 m133 F m | m 133 F m | m 133 F m | m 133 F m | m 133 F m | m 133 F m | m 133 F m | m 133 F m | m 133 F m | m 133 F m | m 133 F m | m 133 F m | m 133 F m | m 133 F m | m 133 F m | m 133 F m | | | |
| 7 | 17:38 176.7 2L163 7000 | -6.6.26JW.3920 m100 F m | m 100 F m | m 100 F m | m 100 F m | m 100 F m | m 100 F m | m 100 F m | m 100 F m | m 100 F m | m 100 F m | m 100 F m | m 100 F m | m 100 F m | m 100 F m | m 100 F m | m 100 F m | | | |
| 8 | 17:38 180.4 1L161 7100 | -6.5.44JW.7022 m120 F m | m 120 F m | m 120 F m | m 120 F m | m 120 F m | m 120 F m | m 120 F m | m 120 F m | m 120 F m | m 120 F m | m 120 F m | m 120 F m | m 120 F m | m 120 F m | m 120 F m | m 120 F m | | | |
| 9 | 17:39 190.6 2L161 7000 | -6.8.13JW.2017 m 83 F m | m 83 F m | m 83 F m | m 83 F m | m 83 F m | m 83 F m | m 83 F m | m 83 F m | m 83 F m | m 83 F m | m 83 F m | m 83 F m | m 83 F m | m 83 F m | m 83 F m | m 83 F m | | | |
| 10 | 17:40 200.8 2L161 7000 | -6.8.27JW.3817 m136 F m | m 136 F m | m 136 F m | m 136 F m | m 136 F m | m 136 F m | m 136 F m | m 136 F m | m 136 F m | m 136 F m | m 136 F m | m 136 F m | m 136 F m | m 136 F m | m 136 F m | m 136 F m | | | |
| 11 | 17:41 210.6 2L163 6900 | -6.7.29JW.4221 m 92 F m | m 92 F m | m 92 F m | m 92 F m | m 92 F m | m 92 F m | m 92 F m | m 92 F m | m 92 F m | m 92 F m | m 92 F m | m 92 F m | m 92 F m | m 92 F m | m 92 F m | m 92 F m | | | |
| 12 | 17:41 220.7 2L163 6900 | -6.7.10JW.1422 m 26 F m | m 26 F m | m 26 F m | m 26 F m | m 26 F m | m 26 F m | m 26 F m | m 26 F m | m 26 F m | m 26 F m | m 26 F m | m 26 F m | m 26 F m | m 26 F m | m 26 F m | m 26 F m | | | |
| 13 | 17:42 23E 1 3L163 6900 | -6. | | | | | | | | | | | | | | | | | | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 28

| Rec. No. | | Card (Record) Contents | | Card Column No. | | 111111111122222222223333333333444444445555555555666666666677777777778 | | 1234567890123456789012345678901234567890123456789012345678901234567890 | |
|----------|-----------------------------------|------------------------|-------|-----------------|----------------|---|-------------|--|-----|
| 1 | CldSysA021479MCC UMY Sierra Co-op | 514CuOrSM35 | m0 | 120 | U | mP | Um2FCfAWkLc | | 1 |
| 2 | 19.522610.4 | 1L187 | 8000 | -8.4.25JW.2423 | m38 | F | m | N | 2 |
| 3 | 19.55 620.5 | 2L183 | 8000 | -8.5.84JW1.123 | m174 | F | m | N | 3 |
| 4 | 20.04 660.5 | 2L181 | 7900 | -8.6.75JW.6219 | m170 | F | m | N | 4 |
| 5 | 20.10 680.5 | 1L177 | 8000 | -8.1.47JW.4821 | m102 | F | m | N | 5 |
| 6 | 20.11 680.3 | 9L181 | 7900 | -8.7.92JW1.019 | m268 | F | m | N | 6 |
| 7 | 20.12 700.4 | 1L187 | 8000 | -9.3.18JW.2119 | m55 | F | m | N | 7 |
| 8 | 20.13 710.7 | 2L183 | 7900 | -9.2.23JW.2216 | m97 | F | m | N | 8 |
| 9 | 20.18 720.5 | 1L177 | 7900 | -8.3.43JW.5024 | m72 | F | m | N | 9 |
| 10 | 20.19 730.3 | 9L187 | 8000 | -6.5.88JW.9320 | m220 | F | m | N | 10 |
| 11 | CldSysA021479MCC UMY Sierra Co-op | 532CuOrSM35 | m0 | 120 | U | mP | Um2FCfAWkLc | | 1 |
| 12 | 20.20274A.5 | 2L181 | 8000 | -7.8.32JW.3922 | m66 | F | m | N | 2 |
| 13 | 20.28 78J | 1L177 | 8000 | -8.7.27JW.2821 | m60 | F | m | N | 3 |
| 14 | 20.34 790.6 | 2L187 | 8000 | -8.2.27JW.3221 | m69 | F | m | N | 4 |
| 15 | CldSysA021479MCC UMY Sierra Co-op | 518CuOrSM35 | m0 | 120 | U | mP | Um2FCfAWkLc | | 1 |
| 16 | 20.262750.7 | 2L185 | 8000 | -9.1.42JW.3417 | m130 | F | m | N | 2 |
| 17 | 20.27 760.5 | 2L181 | 8000 | -9.2.35JW.3016 | m134 | F | m | N | 3 |
| 18 | 20.27 770.5 | 2L181 | 8000 | -9.1.74JW.6018 | m103 | F | m | N | 4 |
| 19 | 20.35 810.5 | 2L185 | 8000 | -8.5.47JW.4018 | m172 | F | m | N | 5 |
| 20 | 20.36 820.5 | 1L171 | 8000 | -8.0.55JW.5619 | m152 | F | m | N | 6 |
| 21 | CldSysA021479MCC UMY Sierra Co-op | 528CuOrSM35 | m0 | 120 | U | mP | Um2FCfAWkLc | | 1 |
| 22 | 20.342800.5 | 2L183 | 8100 | -8.01.1JW1.119 | m329 | F | m | N | 2 |
| 23 | 20.37 83J.8 | 2L171 | 8000 | -8.2.27JW.3820 | m97 | F | m | N | 3 |
| 24 | 20.44 840.1 | 3L185 | 8000 | -9.0.14JW.2323 | m37 | F | m | N | 4 |
| 25 | 20.46 860.5 | 1L177 | 9000 | -10.7.39JW.3319 | m95 | F | m | N | 5 |
| 26 | CldSysA021479MCC UMY Sierra Co-op | 543CuOrSM35 | m0 | 120 | U | mP | Um2FCfAWkLc | | 1 |
| 27 | 20.452850.5 | 2L187 | 8900 | -9.9.27JW.4320 | m96 | F | m | N | 2 |
| 28 | 20.47 87J.8 | 2L189 | 9000 | -10.0.50JW.6921 | m134 | F | m | N | 3 |
| 29 | 20.55 880.8 | 2L189 | 9000 | -10.3.24JW.3422 | m83 | F | m | N | 4 |
| 30 | 20.59 890.8 | 2L175 | 9000 | -10.2.18JW.2922 | m53 | F | m | N | 5 |
| 31 | CldSysA021679BLU UMY Sierra Co-op | 524CuOrU | U | U | U | mP | Um2FWkCf | | 1 |
| 32 | 18.382 | 10.9 | 3L169 | 7900 | -7.5.52JW.4227 | m42 | F | m | 2 |
| 33 | 18.39 | 20 | 4L161 | 7800 | -7.5.24JW.1922 | m35 | F | m | 3 |
| 34 | 18.44 | 36.6 | 2L187 | 7800 | -7.8.20JW.2423 | m37 | F | m | 4 |
| 35 | 18.45 | 40.3 | 7L181 | 7800 | -7.6.31JW.3819 | m98 | F | m | 5 |
| 36 | 18.47 | 50.9 | 3L183 | 7800 | -7.6.19JW.2716 | m117 | F | m | 6 |
| 37 | 18.48 | 60.6 | 2L187 | 7800 | -7.4.12JW.1519 | m43 | F | m | 7</ |

1111111111222222222233333333334444444444555555555566666666677777777778
1234567890123456789012345678901234567890123456789012345678901234567890

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 29

[illegible]

Note: On type "2" records for U. Wyo. Sierra Co-op data (Files 28-31), columns 36-37 contain approximate MVDs estimated from $MVD = \text{mean dia.} = 100 \times (\text{cube root of } 6 \times LWC / (\pi \times \text{conc})),$

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 30

| Card Column No. | | Card (Record) | | Contents | | Card Column No. | | Card (Record) | | Contents | | Card Column No. | | Card (Record) | | Contents | |
|--|--|---------------|--------|----------|-----------------|-----------------|----------------|---------------|---|----------|---|-----------------|---|---------------|---|----------|---|
| 1111111111222222222233333333334444444444555555555566666666667777777777 | 1234567890123456789012345678901234567890123456789012345678901234567890 | 1 | 16:512 | 1J 1 | 3P175 | 8600 | -8.8.20JW.1921 | m 38 | F | m | m | m | m | m | m | m | m |
| 2 | 16:55 | 20.8 | 2P171 | 6800 | -4.6.24JW.2721 | m 53 | F | m | m | m | m | m | m | m | m | m | m |
| 3 | 17:00 | 36.5 | 1P179 | 6600 | -4.0.49JW.4725 | m 57 | F | m | m | m | m | m | m | m | m | m | m |
| 4 | 17:01 | 40.1 | 3P173 | 5800 | -2.5.31JW.3220 | m 82 | F | m | m | m | m | m | m | m | m | m | m |
| 5 | 17:03 | 53.4 | 1L183 | 5800 | -2.3.46JW.4924 | m 71 | F | m | m | m | m | m | m | m | m | m | m |
| 6 | 17:05 | 6J 1 | 3L169 | 4800 | -0.5.28JW.3020 | m 76 | F | m | m | m | m | m | m | m | m | m | m |
| 7 | 17:08 | 7J 1 | 3P173 | 4900 | -1.1.29JW.4318 | m 152 | F | m | m | m | m | m | m | m | m | m | m |
| 8 | 17:10 | 8A.9 | 2P165 | 7600 | -6.0.27JW.3022 | m 57 | F | m | m | m | m | m | m | m | m | m | m |
| 9 | 17:12 | 90.2 | 6L192 | 11300 | -13.8.10JW.2128 | m 19 | F | m | m | m | m | m | m | m | m | m | m |
| 10 | 17:19 | 100.2 | 5L206 | 11300 | -14.2.28JW.3126 | m 35 | F | m | m | m | m | m | m | m | m | m | m |
| 11 | 17:20 | 110.2 | 8L197 | 11200 | -13.6.16JW.2231 | m 15 | F | m | m | m | m | m | m | m | m | m | m |
| 12 | 17:22 | 120.3 | 9P183 | 11200 | -13.3.23JW.2831 | m 18 | F | m | m | m | m | m | m | m | m | m | m |
| 13 | 17:25 | 130.2 | 6P182 | 10000 | -11.0.20JW.2630 | m 18 | F | m | m | m | m | m | m | m | m | m | m |
| 14 | 17:27 | 140.8 | 3P189 | 9500 | -8.0.12JW.1531 | m 10 | F | m | m | m | m | m | m | m | m | m | m |
| 15 | 17:28 | 150.9 | 3P185 | 7800 | -6.1.10JW.1529 | m 12 | F | m | m | m | m | m | m | m | m | m | m |
| 16 | 17:30 | 160.7 | 2P187 | 7000 | -4.8.23JW.1722 | m 31 | F | m | m | m | m | m | m | m | m | m | m |
| 17 | 17:32 | 18E.7 | 2P173 | 5700 | -2.6.28JW.3520 | m 82 | F | m | m | m | m | m | m | m | m | m | m |
| 18 | 17:33 | 19A.5 | 1P183 | 5500 | -2.0.24JW.2218 | m 68 | F | m | m | m | m | m | m | m | m | m | m |
| 19 | 17:34 | 200.2 | 7L191 | 8800 | -8.5.20JW.2427 | m 23 | F | m | m | m | m | m | m | m | m | m | m |
| 20 | 17:36 | 210.7 | 2L187 | 9800 | -8.4.12JW.1231 | m 6 | F | m | m | m | m | m | m | m | m | m | m |
| 21 | 18:01 | 220.2 | 5L185 | 9800 | -8.3.14JW.2029 | m 18 | F | m | m | m | m | m | m | m | m | m | m |
| 22 | 18:04 | 230.5 | 2L191 | 8800 | -8.0.20JW.2222 | m 41 | F | m | m | m | m | m | m | m | m | m | m |
| 23 | 18:08 | 240.1 | 3L179 | 6900 | -5.3.49JW.4425 | m 53 | F | m | m | m | m | m | m | m | m | m | m |
| 24 | 18:09 | 250.1 | 4L187 | 6800 | -4.8.15JW.1327 | m 12 | F | m | m | m | m | m | m | m | m | m | m |
| 25 | 18:15 | 260.6 | 2L185 | 7900 | -6.5.23JW.2527 | m 25 | F | m | m | m | m | m | m | m | m | m | m |
| 26 | 18:16 | 270.5 | 1L1 | | | | | | | | | | | | | | |

Note: On type "2" records for U. Wyo. bierra Co-op data (Files 26-31), columns 36-37 contain approximate MVDs estimated from $MVD = \text{mean dia.} \cdot 100 \times (\text{cube root of } 6 \times LWC / (\pi \times \text{conc}))$.

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 31

[illegible]

Note: On type 'Z' records for U. Wyo. Sierra Co-op data (Files 26-31), columns 36-37 contain approximate MVDs estimated from $MVD = \text{mean dia.} = 100 \times (\text{cube root of } 8 \times LWC / (\pi \times \text{conu}))$.

Data Files 32 to 34, 37 to 39, and 43

are blank

as of the date of this report.

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 35

Card Column No.-----

11111111112222222222333333333344444444445555555555666666666677777777778

12345678901234567890123456789012345678901234567890123456789012345678901234567890

Rec. No. Card (Record) Contents

1 CldGrp1032481W72 NRL S 0 Cu VM34m-2.2 64 -7.0 McLeCv0 GulfStream1

2 1142 1A 1 4L217W5400M-6.0.56JW X 1931 X A N N X NN U M9CRO N N N 0 W 2

3 1145 2A.7 2L215W5300 -4.6.15JW X 1728 X A N N X NN U M2CRO N N N 0 W 2

4 1150 3J.1.4L220M6400 -6.3.82JW X 1928 X A N N X NNW.8M3CRO N N N 0 W 2

5 1151 4A.1.3L220 6400 -5.71.2JW X 1928 X A N N X NNW.8M3CRO N N N 0 W 2

6 1153 5J.2.8L222 6500 -7.3.8 JW X 2031 X A N N X NNW.6M23CRO N N N 0 W 2

7 1154 6J.3 1L222 6600 -6.4.5JW X 2031 X A N N X NNW.5M18CRO N N N 0 W 2

8 1154 7J.1.5L222 6600 -6.8.6JW X 2031 X A N N X NNW.3M10CRO N N N 0 W 2

9 1154 8J.1.4L222 6600 -6.8.4 JW X 2031 X A N N X NNW.8M23CRO N N N 0 W 2

10 1154 9 J.2.7L222 6600 -6.6.6JW X 2031 X A N N X NNW.2M10CRO N N N 0 W 2

11 CldGrp2032481W72 NRL S 0 Cu VM34m-2.2M74m-7.0 McLeCv0 GulfStream1

12 1200 1A.1.5L222M7100 -6.41.1JW X 2128 X A N N X NNW.6M24CRO N N N 0 W 2

13 1202 2A.3 1L220M6200 -5.5.32JW X 1928 X A N N X NNW.3M13CRO N N N 0 W 2

14 CldGrp3032481W72 NRL S 0 Cu V 34 -2.2 68M-5.0 McLeCv0 GulfStream1

15 1228 1J.2.7L210 3750 -3.7.1JW X 9 U X A N N X NN U M0 CRO N N N 0 W 2

16 1230 2J.2.6L210 3750 -3.3.20JW X 9 U X A N N X NN U M0 CRO N N N 0 W 2

17 1232 3J.1.5L210 3750 -3.0.28JW X 9 U X A N N X NN U M0 CRO N N N 0 W 2

18 1235 4A.2.6L216 5400 -5.0.35JW X 1425 X A N N X NN U M0 CRO N N N 0 W 2

19 1240 5J.1.5L217 5600 -6.2.56JW X 1425 X A N N X NN U M0 CRO N N N 0 W 2

20 1242 6A.1.4L218 8100 -6.4.7 JW X 1625 X A N N X NN U M0 CRO N N N 0 W 2

21 1249 7J.2.6L218 8100 -6.5.30JW X 1628 X A N N X NN U M0 CRO N N N 0 W 2

22 1254 9A.1.2L218 6400 -7.0.8JW X U U X A N N X NN U M0 CRO N N N 0 W 2

23 1255 9A.1.2L218 6400 -7.01.0JW X U U X A N N X NN U M0 CRO N N N 0 W 2

24 1256 10A.1.2L218 6400 -7.0.9JW X U U X A N N X NN U M0 CRO N N N 0 W 2

25 1256 11A.1.4L218 6400 -7.01.0JW X U U X A N N X NN U M0 CRO N N N 0 W 2

26 1300 12A.1.2L218 6400 -7.0.9JW X U U X A N N X NN U M0 CRO N N N 0 W 2

27 1301 13A.1.4L218 6400 -7.0.8JW X U U X A N N X NN U M0 CRO N N N 0 W 2

28 1301 14A.1.5L218 6500 -7.5.8JW X U U X A N N X NN U 25CRO N N N 0 W 2

29 1305 15A.3 1L218 6200 -7.51.0JW X 1525 X A N N X NN U 12CRO N N N 0 W 2

30 Cloud 1032681nL NRL P 6 Cu VM70 U M90M-10 cP <1ASmCf

31 1352 1A.2 1L244 8900 -9.4.52JW.371119560 A N N 0 NN.4 18CRO N N N 0 W 2

32 CldGrp2032681GSH NRL P 6 Cu V U U U cP 0-.1ASmCf,MTb

33 1453 1J 2 9L26011000-13.5.13JW X X X A N N U NN.12 5CRO N N N 0 W 2

34 1455 2G.1.4L26011000-13.1.21JW.141019360 A N N U NN.24 11CRO N N N 0 W 2

35 1455 3G.1.4L26011000-12.6.61JW.681422730 A N N U NN.X X RO N N N 0 W 2

36 1455 4D.6 3L26011000-12.3.26JW.271119670 A N N U NN.36 15CRO N N N S WS 2

37 1456 5A.5 2L26011000-12.0.13JWsnow cntam A N N U NN.26 X RO N N N S WS 2

38 1459 6D.2.7L25011000-10.8.37JW.391222680 A N N U NN.40 17CRO N N N 0 W 2

39 1459 7J.2.7L25011000-10.7.24JW.221022680 A N N U NN.22 13CRO N N N 0 W 2

40 1503 8J.3 1L23011000-10.4.30JWsnow cntam A N N U NN.52 24CRO N N N S WS 2

41 1508 9F.3 1L240 8900 -6.6.41JWsnow cntam A N N U NN.32 X RO N N N S WS 2

42 1509 10J.3 1L230 8800 -6.6.20JWsnow cntam A N N U NN.21 9C RO N N N S WS 2

43 1510 11F.6 2L230 8100 -4.4.38JWsnow cntam A N N U NN.44 19CRO N N N S WS 2

44 1511 12J.5 2L230 8000 -4.0.22JWsnow cntam A N N U NN.23 12CRO N N N S WS 2

45 Cloud 3032681VWV NRL P6 CuCbC U U cP M0-.2ASmCf,SrTb

46 1512 1A 2 7L226 8000 -5.1.52JW.301019610 A N N U NN.40 19CRO N N N S WS 2

47 Cloud 4032681nOH NRL P 6 U C U U cP 0-.3F5mCf,MTb

48 1547 1A 2 9L222M7000-10.8.22JW.421322650 A N N U NN.27 U RO N N N 0 W 2

49 CldGrp1031981HOR NRL S M Sc 1M55-13.0100-23.0cP NyWM7W&FLc

50 1527 1A.3 1L230 7000-18.0.46JW N N N N N X N N X RO N N N UmmW 2

51 1551 2A.5 2L230 6000-18.0M.2JW N N N N N X N N.19 U CRO N N N UmmW 2

52 CldGrp2031981JST NRL S M Sc 1M48-13.0 U U cP NyWM7W&FLc

53 1558 1A 2 7L230 5800-16.0.25JW N N N N N X N N.18 U CRO N N N UmmW 2

54 1601 2A.5 2L230 5600-15.2.18JW N N N N N X N N.18 U CRO N N N 0 W 2

55 1606 3F.5 2L230 5000-13.9.11JW N N N N N X N N.12 .4CRO N N N S- WS 2

56 1607 4A 1 6L220 5000-13.2.28JW N N N N N X N N.28 5CRO N N N S- WS 2

57 CldGrp3031981HOR NRL S M Sc 1M41M-13 M70-18.5cP NyWM7W&FLc,C1L01

58 1631 1A.3 1L230 5000-13.5.23JW N N N N N X N N.25 U RO N N N S WS 2

59 1643 2A.5 2L230 6900-16.9.48JW N N N N N X N N.50 U RO N N N 0 W 2

11111111112222222222333333333344444444445555555555666666666677777777778

12345678901234567890123456789012345678901234567890123456789012345678901234567890

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 36

| | | -----Card Column No.----- | |
|------|---------------------------------|---|-----------------------------|
| | | 11111111112222222222333333333344444444445555555555666666666677777777778 | |
| | | 1234567890123456789012345678901234567890123456789012345678901234567890 | |
| Rec. | No. | Card (Record) Contents | |
| 1 | CldGrp40J1981IAD NRL | S 3 Sc I#68M-15 | *90M-22 cP NyW*7W&FLc,UpC11 |
| 2 | 1705 1F.5 2L230 7000-15.6.24JW | N N N N N N N N X N N.17 U | RO N N N S- WS 2 |
| 3 | 1706 2A 2 8L230 7000-15.5.12JW | N N N N N N N N X N N.10 | 4CR0 N N N S- WS 2 |
| 4 | CldGrp1041781oME NRL | S U St Cm90M-7.8120 U | MaTSyW,W&FHc&R,CIL01 |
| 5 | 1430 1A 2 9L23011000-10.0 N | JW N N N N N N N N N N.249.6CR0 | N N N 0 W 2 |
| 6 | 1439 2E N NP210 9700 -8.1 N | JW.031641135 A N N N N N.082.7CR0 | N N N 0 W 2 |
| 7 | 1439 3E N NP21010200 -8.1 N | JW.221728180 A N N N N N.25 10CR0 | N N N 0 W 2 |
| 8 | 1440 4D 1 4L21010700 -7.8 N | JW.321828350 A N N N N N.32 13CR0 | N N N 0 W 2 |
| 9 | 1441 5D 2 5L21010700 -7.6 N | JW.271422290 A N N N N N.33 13CR0 | N N N 0 W 2 |
| 10 | 1442 6D.5 2L21010700 -7.5 N | JW.03 716470 A N N N N N.26 11CR0 | N N N 0 W 2 |
| 11 | 1443 7D 2 6L21010700 -7.4 N | JWsnow cntam A N N N N N.093.0CR0 | N N N S- WS 2 |
| 12 | 1445 8A 2 8L22010700 -7.3 N | JWsnow cntam A N N N N N.197.6CR0 | N N N S- WS 2 |
| 13 | 1502 9F.8 3L23511000 -8.6 N | JWsnow cntam A N N N N N.103.9CR0 | N N N S- WS 2 |
| 14 | 1503 10F 417L23511000 -7.7 N | JWsnow cntam A N N N N N.249.6CR0 | N N N S- WS 2 |
| 15 | 1507 11F 310L23511000 -6.2 N | JW.081525320 A N N N N N.177.0CR0 | N N N 0 W 2 |
| 16 | 1510 12A 624L23511000 -4.5 N | JW.201322330 A N N N N N.28 11CR0 | N N N 0 W 2 |
| 17 | Cloud A121980oMA NRL | S 0 Sc B#60 U | *80M-13 cP 1-2FSmDycf |
| 18 | 1435 1J.3 1L218 7500M-12 .29JW | X X X X A N N X NN.32 16CR0 | N N N 0 W 2 |
| 19 | 1436 2F.4 1L218 7500M-12 .12JW | X X X X A N N X NN.16 12CR0 | N N N 0 W 2 |
| 20 | 1437 3J.2.7L218 7500M-12 .28JW | X X X X A N N X NN.56 18CR0 | N N N 0 W 2 |
| 21 | 1438 4J 1 4L218 7500M-12 X JW | X X X X A N N X NN.35 16CR0 | N N N 0 W 2 |
| 22 | 1439 5J.3 1L218 7500M-12 X JW | X X X X A N N X NN.35 14CR0 | N N N 0 W 2 |
| 23 | 1441 6J.3 1L218 7500M-12 X JW | X X X X A N N X NN.196.7CR0 | N N N 0 W 2 |
| 24 | 1447 7J.3 1L217 7000-11.5.23JW | X X X X A N N X NN.23 10CR0 | N N N 0 W 2 |
| 25 | 1449 8F.3 1L245 7000-11.5.12JW | X X X X A N N X NN.197.1CR0 | N N N 0 W 2 |
| 26 | 1450 9J.4 2L245 7000-11.5.20JW | X X X X A N N X NN.27 14CR0 | N N N 0 W 2 |
| 27 | 1450 10J.2 1L245 7000-11.5.14JW | X X X X A N N X NN.199.5CR0 | N N N 0 W 2 |
| | | 11111111112222222222333333333344444444445555555555666666666677777777778 | |
| | | 1234567890123456789012345678901234567890123456789012345678901234567890 | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 40

```
-----Card Column No.-----
11111111112222222222333333333344444444445555555555666666666677777777778
1234567890123456789012345678901234567890123456789012345678901234567890
```

| Rec. | Card (Record) | Contents |
|------|---|-------------------------------------|
| No. | | |
| 1 | F298C1A1216740LMUWSH QJRMetSoc.v106 S 0 Cu C 30 U | 200 U mP 0-.1ACfSu@F1 1 |
| 2 | 15.13L 1G 1 3L126 7000 -3 .3 JW N N N m A N N N 10W N | N N N N N S- W+12 |
| 3 | 15.14 2G 1 3L130 7000 -3 .15JW N N N m A N N N 30W N | N N N N N S- m1 2 |
| 4 | 15.16 3G 2.4L130 7000 -3 .55JW N N N m A N N N 2W N | N N N N N U mW 2 |
| 5 | 15.16 4G 5.1L130 7000 -3 .7 JW N N N m A N N N 5W N | N N N N N N 0 mW+12 |
| 6 | F298C1B1216740LMUWSH QJRMetSoc.v106 S 0 Na C 45 #0 | 200 U mP 0-.2FCfSu@F1 1 |
| 7 | 15.17L 1G1022L130 7000 -4 .06JW N N N m A N N N 10W N | N N N N N S- m1 2 |
| 8 | F298C1C1216745EAUWSH QJRMetSoc.v106 S 0 Cu C 30 U | 200 U mP 0-.1ACfSu@F1 1 |
| 9 | 16.23L 1G 4 1L130 8000 -3 .3 JW N N N m A N N N 15W N | N N N N N S- W+1 |
| 10 | 16.24 2G 1.2L130 7500 -3 1.0JW N N N m A N N N 3W N | N N N N N N 0 mW 2 |
| 11 | 16.27 3G 2.4L130 7500 -2 .5 JW N N N m A N N N 8W N | N N N N N S- W+12 |
| 12 | F298C1D1216745EAUWSH QJRMetSoc.v106 S 0 Cb C 30 U | 200 U mP 0-.1ACfSu@F1 1 |
| 13 | 16.42L 1G 2 4L124 7000 -2 .17JW N N N m A N N N 15W N | N N N N N S- m1 2 |
| 14 | 16.44 2G 3 6L124 7000 -1 .45JW N N N m A N N N 4W N | N N N N N N 0 mW+12 |
| 15 | 16.49 3G 5 1L124 7000 -1 .2 JW N N N m A N N N 3W N | N N N N N N 0 mW+12 |
| 16 | 16.50 4G 4 1L124 7000 -1 1.1JW N N N m A N N N 1W N | N N N N N N 0 mW 2 |
| 17 | F298C1E1216745EAUWSH QJRMetSoc.v106 S 0 Cu C 30 U | 200 U mP .2-.4ACfSu@F1 1 |
| 18 | 16.52L 1G 4 8L120 7000 -1 .2 JW N N N m A N N N 5W N | N N N N N S- m1 2 |
| 19 | 16.57 2G 4 8L120 7000 -1 .1 JW N N N m A N N N 5W N | N N N N N S- m1 2 |
| 20 | F301C1A0102755EAUWSHQJRMetSoc106.p295 0 Cu B 30 U | #95 U mP CvOO@Wf, .2F4#Rb1 |
| 21 | 14.48L 1G 3 7L122 5400 -2.4.17JW N 9 N 500 | A N N N .2W N N N N N 0 W 2 |
| 22 | 14.51 2G 2 3L122 5500 -2.7.23JW N 8 N 700 | A N N N .1W N N N N N 0 W 2 |
| 23 | 14.54 3G 3 7L122 5400 -2.4.14JW N 8 N 550 | A N N N .1W N N N N N 0 W 2 |
| 24 | 14.57 4G 2 3L112 5400 -2.6.08JW N 8 N 350 | A N N N .1W N N N N N 0 W 2 |
| 25 | F301C1B0102755LUMWSHQJRMetSoc106.p295 0 Cu I U U | U mP CvOO@Wf, .6ACf 1 |
| 26 | 15.40L 1G 2 3L120 7400 -1.3.21JW N 25N 25 | A N N N 1W N N N N N 0 mW+12 |
| 27 | 15.42 2J 2 4L120 7400 -1.4.26JW N 20N 60 | A N N N 1W N N N N N 0 mW+12 |
| 28 | F301C1C0102755HUMWSHQJRMetSoc106.p295 0 Cu C 30 U | #+1 >99 <-15mP Ud@CFsu@F1, 43mRb1 |
| 29 | 16.06L 1G 3 7L134 7600 -2.8.07JW N 10N 125 | A N N N 98W N N N N N S- m1 2 |
| 30 | 16.09 2G 1 3L140 7800 -4.31.1JW N 16N 500 | A N N N 15W N N N N N S-mW+12 |
| 31 | 16.11 3G 2 4L135 7800 -4.0.21JW N 11N 290 | A N N N 99W N N N N N S-m1+W2 |
| 32 | 16.25 4J 4 8P13010000 -7.5.14JW N 11N 200 | A N N N 30W N N N N N S- 1+W2 |
| 33 | F301C1D0102755EAUWSHQJRMetSoc106.p295 05t5c U | U U mP m.6AWKcf 1 |
| 34 | 18.24L 1H 511L124 6500 -3.7.27JW N 10N 460 | A N N N .2W N N N N N N 0 mW 2 |
| 35 | 18.30 2A 2 3L124 6400 -3.6.09JW N 8 N 320 | A N N N 0W N N N N N N 0 W 2 |
| 36 | F733C1A020279237UWSH Priv Comm 1982 S 0 Sc C#60 | -2.8 79 U mP 1W#ASf, #2-3E#ACf1 |
| 37 | 12.34L 1G 612L125 6445 -6.4.84JW.782734125 | A2.1 0 36.1W N N N N N N E-mW+12 |
| 38 | 12.37 2K.5 1L119 6770 -4.5.99JW.822839109 | A 11 0 31.1W N N N N N N E-mW+12 |
| 39 | 12.46 3E.6 1L119 6770 -4.3 X JW.382634 69 | A 183.797.1W N N N N N N N 0 mW 2 |
| 40 | 12.48 4E1020L119 6290 -4.3.44JW.522540103 | A X 1.299.1W N N N N N N N 0 mW 2 |
| 41 | F733C1B020279237UWSH Priv Comm 1982 S 0 St C 24 | +1.0 43 -1.2mP 1W#ASf, #2-3E#ACf1 |
| 42 | 13.02L 1E N NP120 4280 -1.3 X JW.322439 85 | A X .199.1W N N N N N N E-mW+12 |
| 43 | 13.03 2E N NP120 3760 -1.7 X JW.291832175 | A X .399.1W N N N N N N E-mW+12 |
| 44 | 13.03 3E N NP120 3270 -1.1 X JW.331624253 | A X .399.1W N N N N N N E-mW+12 |
| 45 | 13.04 4E N NP120 2725 -0.3 X JW.171434199 | A X .259.2W N N N N N N E-mW+12 |
| 46 | 13.04 5E N NP120 2450 -0.1 X JW.041035149 | A X .543.1W N N N N N N E-mW+12 |
| 47 | F733C1C020279237UWSH Priv Comm 1982 S 0 St C 48 | -0.6 62 -2.4mP 1W#ASf, #2-3E#ACf1 |
| 48 | 13.20L 1E N NP122 4930 -0.5 X JW.242025 95 | A 59 .146.1W N N N N N N E W+12 |
| 49 | 13.20 2E N NP121 5310 -1.0 X JW.202228 62 | A 54 .199.1W N N N N N N E W+12 |
| 50 | 13.37 3D 1 3L137 5370 -1.4 X JW.122040 63 | A U 0 6 0W N N N N N N N 0 mW 2 |
| 51 | 13.39 4 2 4L123 5325 -1.3 X JW.242238 74 | A .3 0 28.1W N N N N N N N 0 mW 2 |
| 52 | 13.41 5J.7 1L123 5350 -1.2 X JW.101740 67 | A1.1 0 40.1W N N N N N N N 0 mW 2</ |

111111111122222222233333333344444444455555555566666666677777777778
1234567890123456789012345678901234567890123456789012345678901234567890

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 41

| -----Card Column No.----- | |
|---|--|
| 11111111112222222222333333333344444444445555555555666666666677777777778 | |
| 1234567890123456789012345678901234567890123456789012345678901234567890 | |
| Rec. No. | Card (Record) Contents |
| 1 | F733C1E020279237UWSH Priv Comm 1982 S 0 Sc B 22 +0.6 U U mP 1W&ASf, a2-JE&ACf1 |
| 2 | 15,15L 10 1 2L123 2640 -0.1.25JW.16 921362 A X 1.1444.W N N N N N N SP W+12 |
| 3 | 15,17 2J 1 2L127 2580 -0.9.19JW.08 7 X347 A X 0 66.7W N N N N N N SP W+12 |
| 4 | F733C1F020279HQMUSH Priv Comm 1982 S 0 Sc B 28 -0.5 U U mP 1W&ASf, a2-JE&ACf1 |
| 5 | 15,25L 1J 2 4L125 3085 -0.7.37JW.201030382 A X .8302.W N N N N N N E-mw+12 |
| 6 | 15,30 2E 3 5L118 3090 -1.6.35JW.251018530 A X .5572.W N N N N N N E-mw+12 |
| 7 | 15,33 3E N NP111 3595 -2.2.55JW.521725330 A X .6873.W N N N N N N E-mw+12 |
| 8 | 15,35 4D 1 2L116 4040 -2.9.40JW.361527290 A X .4905.W N N N N N N E-mw+12 |
| 9 | 15,36 5G 1 2L119 4055 -2.6.21JW.1410 X285 A X .69911W N N N N N N E W+12 |
| 10 | 15,37 6G 2 4L117 4070 -2.1.09JW.0710 X165 A X .58011W N N N N N N E W+12 |
| 11 | 15,39 7E 2 5L117 4070 -2.1.58JW.331732175 A X .299.6W N N N N N N E-mw+12 |
| 12 | 15,41 8K.6 1L112 4260 -1.9.75JW.661828230 A X .322.1W N N N N N N #0 mW 2 |
| 13 | 15,43 9K.2.4P115 4615 -2.21.1JW1.02230234 A X .3 2.2W N N N N N N #0 mW 2 |
| 14 | F857C1A021480LMUWSH Priv Comm 1982 S 0 Ac C125-17.8135-21.5cP EyW, NE-SWPg6SWhc1 |
| 15 | 12,12L 1E N NP14712150 -17.8.05JW.0213 X J3 A X 1.1.3W N N N N N N #0 mW 2 |
| 16 | 12,13 2E N NP14112700 -19.1.07JW.061116153 A X X .2.3W N N N N N N #0 mW 2 |
| 17 | 12,15 3E N NP14313250 -20.6.07JW.081215190 A X X .6.1W N N N N N N #0 mW 2 |
| 18 | 12,16 4E N NP14013735 -21.5.17JW.282027122 A X X 2.1W N N N N N N #0 mW 2 |
| 19 | F857C1B021480HQMUSH Priv Comm 1982 S 0 Sc C J3 -4.1 58 -6.1cP EyW, NE-SWPg6SWhc1 |
| 20 | 12,47L 1E N NS145 5505 -5.3.07JW.111525113 A 0? X .6.1W N N N N N N #0 W 2 |
| 21 | 12,48 2E N NS146 5000 -4.5.07JW.151014443 A 0? X 0 .1W N N N N N N #0 W 2 |
| 22 | 12,49 3E N NS145 4520 -3.7.07JW.201324285 A X .120 .1W N N N N N N #0 W 2 |
| 23 | 12,50 4E N NS138 4025 -4.4.17JW.221021780 A .1? X .4.1W N N N N N N #0 W 2 |
| 24 | 42,51 5A N NS133 3480 -4.3.04JW.071229125 A .2? X 2.2W N N N N N N #0 W 2 |
| 25 | F857C1C021480HQMUSH Priv Comm 1982 S 0 Sc C J3 -2.6 46 -3.3cP EyW, NE-SWPg6SWhc1 |
| 26 | 12,56L 1E N NP115 3805 -2.6.04JW.031031104 A X X 2.2W N N N N N N #0 mW 2 |
| 27 | 12,57 2A N NP121 4300 -3.8.17JW.211229450 A X X 1.1.3W N N N N N N #0 mW 2 |
| 28 | F857C1D021480HQMUSH Priv Comm 1982 S 0 St C 49 -3.4 59 -5.0cP EyW, NE-SWPg6SWhc1 |
| 29 | 12,58L 1E N NP123 4940 -3.4.05JW.021020 76 A X X 0 .1W N N N N N N #0 W 2 |
| 30 | 12,59 2E N NP123 5455 -4.4.07JW.121422136 A X X 0 .1W N N N N N N #0 W 2 |
| 31 | 13,00 3A N NP121 5825 -5.0.17JW.211423270 A X X 0 .1W N N N N N N #0 W 2 |
| 32 | 13,01 4J.4.9L128 5900 -5.5.17JW.261221327 A X X .1.1W N N N N N N #0 W 2 |
| 33 | 13,06 5J 2 5L131 5760 -5.7.17JW.271322300 A X X 0 .1W N N N N N N #0 W 2 |
| 34 | 13,09 6J 2 6L132 5435 -5.3.17JW.231221294 A X X 0 .1W N N N N N N #0 W 2 |
| 35 | 13,12 7J 1 3L133 5280 -4.4.06JW.10 821283 A X X 5.1W N N N N N N #0 W 2 |
| 36 | F857C1E021480HQMUSH Priv Comm 1982 S 0 St C U 58 -5.0cP EyW, NE-SWPg6SWhc1 |
| 37 | 13,15L 10 1 3L129 4965 -4.2.09JW.191228304 A X X .9.2W N N N N N N #0 W 2 |
| 38 | 13,17 2D 2 3L124 4965 -4.0.17JW.251224363 A X X 6.1W N N N N N N #0 W 2 |
| 39 | 13,19 3G 511L117 4985 -4.1.27JW.411526310 A X X 1.1W N N N N N N #0 W 2 |
| 40 | 13,25 4G.4.8L123 5005 -3.9.09JW.151222227 A X X 3.2W N N N N N N #0 W 2 |
| 41 | 13,29 5J.7 1L122 5850 -5.2.13JW.241424169 A X X .3.1W N N N N N N #0 W 2 |
| 42 | 13,31 6J 2 5L117 5845 -5.6.27JW.431624270 A X X .4.1W N N N N N N #0 W 2 |
| 43 | 13,34 7G.6 1L123 5860 -6.0.27JW.401522308 A X X 0 .1W N N N N N N #0 W 2 |
| 44 | 13,35 8J 1 2L126 5805 -5.9.27JW.431524287 A X X .2.1W N N N N N N #0 W 2 |
| 45 | 13,36 9J.3.6L127 5750 -5.6.17JW.371527293 A X X .5.1W N N N N N N #0 W 2 |
| 46 | F857C1F021480HQMUSH Priv Comm 1982 S 0 St B U 53 -4.0cP EyW, NE-SWPg6SWhc1 |
| 47 | 13,41L 1E N NP129 5190 -4.1.17JW.251519267 A X X 51.2W N N N N N N #0 W 2 |
| 48 | 13,42 2G 1 2L128 4955 -3.8.09JW.161322203 A X X 22.3W N N N N N N #0 W 2 |
| 49 | 13,43 3G 1 2L118 4985 -3.7.06JW.041223 68 A X X .4.1W N N N N N N #0 W 2 |
| 50 | 13,44 4D 1 3L118 5000 -3.8.06JW.07 926208 A X X 13.1W N N N N N N #0 W 2 |
| 51 | 13,46 5G 1 3L115 5005 -3.8.09JW.171128305 A X X 2. XW N N N N N N #0 W 2 |
| 52 | 13,47 6G.7 1L112 5000 -3.7.08JW.061229135 A X X 11 XW N N N N N N #0 W 2 |
| 53 | 13,49 7D.5 1L116 4980 -3.5.06JW.05 922170 A X X 1. XW N N N N N N #0 W 2 |
| 54 | 13,50 8G 1 2L123 5015 -3.7.08JW.141323194 A X X 11 XW N N N N N N E-mw+12 |
| 55 | 13,52 9G 2 4L124 4995 -3.8.06JW.091124173 A X X 22 XW N N N N N N E-mw+12 |
| 56 | 13,54 10J 4 8L122 5005 -4.1.09JW.181020346 A X X .5 XW N N N N N N #0 W 2 |
| 11111111112222222222333333333344444444445555555555666666666677777777778 | |
| 1234567890123456789012345678901234567890123456789012345678901234567890 | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)

| Rec. No. | | Card (Record) | | Contents | |
|----------|------------------------|---------------------|------------------|------------|----------------------------------|
| 1 | F857C1G021480HQMUSH | Priv | Comm 1982 S 0 Sc | B 47 | -4.0 58 -5.0cP EyW,NE-SWPg6SWHc1 |
| 2 | 14.08L 1J.7 1L120 5845 | -5.1.08JW.171428154 | A X | X 50 XW | N N N N N N N 0 W 2 |
| 3 | 14.17 2E N NP134 5685 | -5.5.17JW.361622317 | A.17 | X 0 XW | N N N N N N N 0 W 2 |
| 4 | 14.18 3E N NP120 5190 | -4.8.17JW.231318380 | A.17 | X 0 XW | N N N N N N N 0 W 2 |
| 5 | 14.19 4E N NP121 4765 | -4.0.04JW.091016276 | A.27 | X 4. XW | N N N N N N N 0 W 2 |
| 6 | F857C1H021480HQMUSH | Priv | Comm 1982 S 0 Sc | B 34 | -2.9 42 -3.1cP EyW,NE-SWPg6SWHc1 |
| 7 | 14.20L 1E N NP123 3940 | -2.9.17JW.231628170 | A 17 | X 6. XW | N N N N N N N S-mW+12 |
| 8 | 14.21 2E N NP131 3400 | -2.7.07JW.151829 88 | A 57 | X 23 XW | N N N N N N N S-mW+12 |
| 9 | 14.39 3E N NP124 3365 | -3.2 X JW.048 8260 | A X | X 3.1.W | N N N N N N N E-mW+12 |
| 10 | 14.40 4E N NP117 3955 | -2.6 X JW.121013423 | A X | X 1.4W | N N N N N N N 0 mW 2 |
| 11 | F857C1I021480HQMUSH | Priv | Comm 1982 S 0 Sc | B 49 | -3.8m57 -6.0cP EyW,NE-SWPg6SWHc1 |
| 12 | 14.50L 1J.9 2L134 5620 | -5.8.17JW.231323250 | A X | X 0.1W | N N N N N N N 0 W 2 |
| 13 | 14.55 2J.4 9L138 4835 | -3.8.07JW.08 715289 | A X | X 4.6W | N N N N N N N S-mW+12 |
| 14 | 15.02 3A.9 2L132 5325 | -4.7.05JW.08 816233 | A X | X 2.9W | N N N N N N N S-mW+12 |
| 15 | 15.10 4J.8 2L135 4925 | -4.5.06JW.06 815181 | A X | X .3.2W | N N N N N N N 0 W 2 |
| 16 | 15.12 5J.3 7L133 4935 | -4.6.08JW.09 815245 | A X | X 1.1W | N N N N N N N 0 W 2 |
| 17 | 15.21 6J.2 5L131 4925 | -4.3.08JW.11 921261 | A X | X 3.1.W | N N N N N N N 0 mW+12 |
| 18 | 15.39 7J.2 4L129 4930 | -4.1.08JW.10 915253 | A X | X .5.3W | N N N N N N N S-mW+12 |
| 19 | 15.51 8A.1 2L127 4345 | -3.2.07JW.07 815203 | A X | X .9.4W | N N N N N N N 0 mW 2 |
| 20 | F881C1A040980LUMUSH | Priv | Comm 1982 S 0 Cu | B 34 | -0.4 75 -5.8mP Um2-3FmCf4Of |
| 21 | 11.13L 1A.6 1L136 8460 | -8.7 X JW.932733147 | A13 | 2.2733.W | N N N N N N N SPmW+12 |
| 22 | 11.23 2A.1 3L142 6305 | -4.8 X JW1.22833183 | A | 71.3314.W | N N N N N N N E-mW+12 |
| 23 | 11.31 3A.2 4L126 4935 | -1.7 X JW.912432209 | A | 0 X 3.1W | N N N N N N N 0 mW 2 |
| 24 | 11.36 4A.4 9L128 4810 | -1.5 X JW.852431151 | A | 161.7133.W | N N N N N N N RW W 2 |
| 25 | F881C1B040980HQMUSH | Priv | Comm 1982 S 0 Cu | B 34 | +1.0 U U mP Um2-3FmCf4Of |
| 26 | 11.43L 1J.6 1L127 4035 | -5.5 X JW.712029210 | A | 2 .8 51.W | N N N N N N N 0 mW 2 |
| 27 | 11.44 2A.4 9L128 3900 | -5.5 X JW.581828241 | A | 8 .5 52.W | N N N N N N N 0 mW 2 |
| 28 | 11.58 3A.8 2L131 4085 | -1.1 X JW.942230224 | A X | X 3.1W | N N N N N N N 0 W 2 |
| 29 | 12.03 4D.2 4L133 5140 | -2.1 X JW.582030200 | A | 11 .7114.W | N N N N N N N SPmW+12 |
| 30 | 12.03 5A.3 6L144 5170 | -2.5 X JW.551728290 | A | 5 .6 62.W | N N N N N N N SPmW+12 |
| 31 | 12.05 6J.2 4L137 5565 | -3.1 X JW.602029206 | A X | X 2.1W | N N N N N N N 0 W 2 |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 44

```

-----Card Column No.-----
11111111112222222222333333333344444444445555555555666666666677777777778
1234567890123456789012345678901234567890123456789012345678901234567890
Rec.
No.      Card (Record) Contents
1 Pass 1 120679HTSAFGL AFGL-TR-810192 P 8St B U U #52#-.8 c .6-1FSuCf,Cf152 1
2 22:57Z 1D 1 3L167 5195 -1.8.25JW.271531300 A N N 2c NN U U RO N N N S- 1+W2
3 22:58 2D 2 5L162 5155 -0.9.16JW.171228370 A N N 1c NN U U RO N N N S- 1+W2
4 Pass 2 120679HTSAFGL AFGL-TR-810192 P 8AaAcB 64 -0.6 U U c .6-1FSuCf,Cf152 1
5 23:01 1H 1 4L177 7185 -1.0.48JW.501734440 A N N 1c NN U U RO N N N S- 1+W2
6 23:03Z 2D 7 2L173 7175 -1.5.22JW.151231350 A N N 1c NN U U RO N N N S- 1+W2
7 23:04 3D 1 3L169 7175 -1.6.13JW.051133145 A N N 1c NN U U RO N N N S- 1+W2
8 23:05 4D 3 8L175 7200 -2.0.25JW.161231380 A N N 2c NN U U RO N N N S- 1+W2
9 23:06 5D 4 1L174 7200 -2.0.18JW.07 832300 A N N 1c NN U U RO N N N S- 1+W2
10 23:09 6H 8 2L182 7980 -2.7.21JW.101030310 A N N 1c NN U U RO N N N S- 1+W2
11 Pass 3 120679HTSAFGL AFGL-TR-810192 P 8AaAcB U U U c .6-1FSuCf,Cf152 1
12 23:14Z 1H 1 3L177 9250 -3.9.16JWsnow ontam A N N 4c NN U U RO N N N S- 1+W2
13 23:15 2H 1 4L178 9260 -3.7.08JWsnow ontam A N N 3c NN U U RO N N N S- 1+W2
14 23:17 3H 2 7L178 9250 -3.6.18JWsnow ontam A N N 3c NN U U RO N N N S- 1+W2
15 Pass 4 120679HTSAFGL AFGL-TR-810192 P 8AaAcB U U 130M-10 c .6-1FSuCf,Cf152 1
16 23:23Z 1J 1 5L18511340 -6.4.29JW.331632340A A N N 55 NN U U RO N N N U mw 2
17 23:26 2J 4 1L18411320 -6.3.31JW.351633365 A N N 56 NN U U RO N N N U mw 2
18 23:28 3J 5 2L18611320 -6.5.34JW.401634335 A N N 55 NN U U RO N N N U mw 2
19 23:27 4J 3 1L18511325 -6.6.44JW.551734410 A N N 55 NN U U RO N N N U mw 2
20 23:27 5J 4 1L18311320 -6.4.29JW.321734270 A N N 56 NN U U RO N N N U mw 2
21 Pass 6 120679HTSAFGL AFGL-TR-810192 P 8AaAcB140-11.5170-18.5c .6-1FSuCf,Cf152 1
22 23:41Z 1D 1 5L18615260-14.5.43JW.451633380 A N N 27 NN U U RO N N N U mw 2
23 23:43 2D 6 2L20015330-15.0.37JW.331532345 A N N 26 NN U U RO N N N U mw 2
24 23:43 3H 4 1L18815270-14.8.16JW.101231240 A N N 27 NN U U RO N N N U mw 2
25 Pass 7 120679HTSAFGL AFGL-TR-810192 P 8AaAcB140-11.5170-18.5c .6-1FSuCf,Cf152 1
26 23:47Z 1A 4 1L20716915-18.5.28JW.241734255 A N N 25 NN U U RO N N N U mw 2
27 Pass 9 120679HTSAFGL AFGL-TR-810192 P 8AaAcB140-11.5170-18.5c .6-1FSuCf,Cf152 1
28 24:09Z 1J 3 1L18714400-13.3.27JW.251634255 A N N 0 NN U U RO N N N U mw 2
29 24:12 2J 3 1L18114390-13.5.21JW.251534355 A N N 0 NN U U RO N N N U mw 2
30 24:13 3H 7 2L18614420-13.6.25JW.351735345 A N N 38 NN U U RO N N N U mw 2
31 Pass 10 120679HTSAFGL AFGL-TR-810192 P 8AaAcB U U 130M-10 c .6-1FSuCf,Cf152 1
32 24:17Z 1D 4 12L17712295 -8.6.39JW.361634300 A N N 29 NN U U RO N N N U mw 2
33 24:23 2H 1 4L17312260 -8.3.56JW.662235325 A N N 1c NN U U RO N N N U mw 2
34 Pass 11 120679HTSAFGL AFGL-TR-810192 P 8AaAcB U U U c .6-1FSuCf,Cf152 1
35 24:28Z 1D 1 5L16710285 -5.3.35JW.261219485 A N N 48 NN U U RO N N N S- 1+W2
36 24:30 2H 1 3L17110300 -5.9.46JW.451734345 A N N 86 NN U U RU N N N S- 1+W2
37 24:32 3H 1 4L16910300 -5.6.17JWsnow ontam A N N 2c NN U U RO N N N S- m1 2
38 Pass 12 120679HTSAFGL AFGL-TR-810192 P 8AaAcB U U U c .6-1FSuCf,Cf152 1
39 24:35Z 1H 3 7L185 8230 -4.7.07JWsnow ontam A N N 1c NN U U RO N N N S- m1 2
11111111112222222222333333333344444444445555555555666666666677777777778
1234567890123456789012345678901234567890123456789012345678901234567890

```

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)

| Rec. No. | | Card (Record) Contents | | Card Column No. | |
|----------|--------|------------------------|------|------------------|------------------|
| 1 | F3 | SysA032779VLLAMP | Priv | Comm 5/82 S27 Sc | 1M44 +1 |
| 2 | 11.12Z | 1J.2.8L200 | 6300 | -3 | .07JW.08 8 U360 |
| 3 | 11.30 | 2J.2.8L195 | 6310 | -3 | .54JW.7313 U702 |
| 4 | F3 | C1d032779VLLAMP | Priv | Comm 5/82 S22 As | 1102 m-9 114m-10 |
| 5 | 11.37Z | 1J.4 1L20810020 | -10 | .09JW.08 8 U325 | F 0 0 |
| 6 | 11.40 | 20.3 1L23411080 | -11 | .33JW.4013 U470 | F .2 .1 |
| 7 | 11.42 | 30.3 1L23711080 | -12 | .35JW.3511 U565 | F .1 .1 |
| 8 | F3 | C1d032779SCALAMP | Priv | Comm 5/82 S17 Cu | I 26 +6 98 -8 |
| 9 | 12.22Z | 1E.7 3L242 6260 | -2 | 1.0JW.6415 U395 | F 4 2 |
| 10 | 12.23 | 20.2 1L236 5460 | 0 | .41JW.3414 U360 | F 8 4 |
| 11 | F4 | C1dA032779SCOLAMP | Priv | Comm 5/82 S 0 5c | C 23 +7 84 -8 |
| 12 | 15.08Z | 10.1.4P187 6160 | -1 | .79JW1.116 U715 | F 2 1 |
| 13 | 15.09 | 20.4 1P195 6710 | -2 | .50JW.9116 U650 | F 2 .6 |
| 14 | 15.10 | 30.7 2P193 7150 | -3 | .31JW.5717 U385 | F 3 1 |
| 15 | 15.10 | 40.8 3P196 7380 | -4 | .70JW1.218 U600 | F 4 2 |
| 16 | 15.11 | 50.1 4P197 7630 | -5 | .75JW.8319 U275 | F 4 1 |
| 17 | 15.12 | 6E 1 3P196 8030 | -6 | .23JW.3716 U220 | F .2 .1 |
| 18 | 15.13 | 7A.5 2P188 8360 | -7 | .49JW.6616 U285 | F .2 .1 |
| 19 | F4 | C1d032779VLLAMP | Priv | Comm 5/82 S27 As | b 80 -3 87 -8 |
| 20 | 16.14Z | 10.4 1L201 8360 | -5 | .38JW.3315 U188 | F .7 .3 |
| 21 | 16.15 | 2J.4 1L203 8350 | -5 | .10JW.07 8 U180 | F .1 0 |
| 22 | 16.18 | 3J.5 2L193 7980 | -4 | .06JW.05 7 U210 | F .1 0 |
| 23 | F4 | C1d032779VLLAMP | Priv | Comm 5/82 S27 Sc | b 44 +3 75 -2 |
| 24 | 16.24Z | 10.3 1L209 7320 | -2 | .22JW.1713 U180 | F 4 2 |
| 25 | 16.25 | 20.2.8L207 7480 | -3 | .32JW.2515 U180 | F 1 .6 |
| 26 | 16.31 | 3J.4 1L194 7490 | -3 | .45JW.4118 U205 | F 1 .6 |
| 27 | 16.33 | 40.8 3L197 6990 | -2 | .17JW.1814 U150 | F 11 8 |
| 28 | 16.34 | 50.5 2L192 6990 | -2 | .13JW.1815 U120 | F 13 6 |
| 29 | 16.38 | 60.3 1L189 6320 | -1 | .14JW.1312 U165 | F 6 3 |
| 30 | 16.39 | 70.3.9L192 6440 | -2 | .49JW.4816 U250 | F 4 2 |
| 31 | 16.39 | 80.4 1L189 6440 | -1 | .18JW.1614 U150 | F 4 3 |
| 32 | 16.39 | 90.4 1L188 6400 | -1 | .15JW.1316 U110 | F 10 5 |
| 33 | F5 | C1dA032879VLLAMP | Priv | Comm 5/82 S27 Sc | B 62 -4 m99 m-11 |
| 34 | 16.56Z | 1J.3.9L192 8750 | -12 | .54JW.7118 U275 | F .2 .2 |
| 35 | 11.17 | 20.1.5L216 8940 | -11 | .59JW.8315 U615 | F 0 0 |
| 36 | 11.20 | 36.1.4L198 8850 | -12 | .52JW.6017 U345 | F .1 0 |
| 37 | 11.22 | 40.2.6L193 9650 | -12 | .43JW.6115 U435 | F .1 0 |
| 38 | 11.24 | 5J.62 L205 8980 | -11 | .90JW.8517 U390 | F 0 0 |
| 39 | 11.25 | 6D.2.6P207 8770 | -11 | .37JW.4215 U320 | F .1 0 |
| 40 | 11.25 | 7D.2.6P210 8430 | -11 | .33JW.3514 U330 | F 0 0 |
| 41 | 11.26 | 8D.2.6P210 8040 | -10 | .34JW.3514 U325 | F .1 .1 |
| 42 | 11.28 | 9J.2.7P199 7740 | -9 | .56JW.5615 U390 | F .1 .1 |
| 43 | F6 | C1d032879VLLAMP | Priv | Comm 5/82 S27 Cu | I 57 -1 122 -16 |
| 44 | 16.15Z | 10.1.5L23911570 | -15 | .85JW.8220 U240 | F 0 0 |
| 45 | 16.18 | 2A.2.7L21611780 | -15 | .61JW.5220 U160 | F .1 0 |
| 46 | 16.27 | 3D.6 2L20210820 | -13 | .22JW.2112 U278 | F .5 .4 |
| 47 | 16.27 | 40.4 1L20110810 | -14 | .38JW.4816 U330 | F 1 1 |
| 48 | 16.30 | 50.4 1L19910620 | -13 | .68JW.7816 U410 | F .7 .5 |
| 49 | 16.30 | 6D.9 3L19010840 | -14 | .28JW.3417 U230 | F 2 |

Doc. Title No. 4b

| Pec. | No. | Card | (Record) | Contents |
|------|--------------------------|--|----------------------------------|----------|
| 1 | F6 CIdA032879SCLAMP Priv | Comm 5/82 S175c | I 36 +2 130 -18 mP Uum3FCf#85WLc | 1 |
| 2 | 15.56 1A.6 2L22112140 | -16 .02JW.0210 U 44 F .2 .2 N NN N N N N N N N N S-WW+12 | | |
| 3 | 16.00 2A.2.8L21211960 | -16 .08JW.0510 U 90 F .1 .1 N NN N N N N N N N N S-WW+12 | | |
| 4 | 16.03 3A.5 2L21612150 | -16 .07JW.0/13 U 74 F .3 .2 N NN N N N N N N N N S-WW+12 | | |
| 5 | F7 CIdA032979VLLAMP Priv | Comm 5/82 S2/5c B 67 -3 100 M-12mMPUpUmFFw#6FCf | | 1 |
| 6 | 13.23 1J.4 1L208 9810 | -13 .43JW.4812 U601 F .4 .3 N NN N N N N N N N N U #mw 2 | | |
| 7 | 13.25 2J.4 1L19910100 | -14 .52JW.6813 U693 F .1 .1 N NN N N N N N N N N U #mw 2 | | |
| 8 | F7 CIdB032979VLLAMP Priv | Comm 5/82 S275c B 77 -8 122 M-19mMPUpUmFFw#6FCf | | 1 |
| 9 | 13.27 1E.4 1L19910700 | -16 .24JW.4113 U582 F .1 .9 N NN N N N N N N N N SPWW+12 | | |
| 10 | 13.28 2J.2.8L20010820 | -18 .52JW.8614 U/06 F .6 .5 N NN N N N N N N N N U #mw 2 | | |
| 11 | 13.28 3G.2.8L19911130 | -18 .32JW.3114 U227 F .2 1 N NN N N N N N N N N SPWW+12 | | |
| 12 | 13.28 4E.4 1L20311160 | -16 .95JW.8216 U365 F .2 1 N NN N N N N N N N N SPWW+12 | | |
| 13 | 13.29 5G.4 1L20011720 | -18 .83JW.8817 U384 F .3 2 N NN N N N N N N N N SPWW+12 | | |
| 14 | 13.30 6D.4 1L20612010 | -19 .82JW.7017 U277 F .7 .6 N NN N N N N N N N N U #mw 2 | | |
| 15 | 13.30 7D.3 1L21411940 | -20 .88JW.7716 U319 F .1 1 N NN N N N N N N N N SPWW+12 | | |
| 16 | 13.31 8J.4 1L20111990 | -20 .10JW.1512 U153 F .2 .2 N NN N N N N N N N N U #mw 2 | | |
| 17 | 13.32 9D.4 1L20611900 | -19 .14JW.1211 U188 F .3 .3 N NN N N N N N N N N U #mw 2 | | |
| 18 | 13.33 10J.2 1L20212010 | -19 .58JW.6018 U228 F .5 4 N NN N N N N N N N N SPWW+12 | | |
| 19 | 13.43 11J.2 8L21512080 | -19 .17JW.1716 U125 F .4 3 N NN N N N N N N N N SPWW+12 | | |
| 20 | 13.45 12D.3 1L20912250 | -19 .23JW.1713 U154 F .5 .3 N NN N N N N N N N N U #mw 2 | | |
| 21 | 13.45 13J.3 1L20912040 | -20 .13JW.07 9 U152 F .1 0 N NN N N N N N N N N U #mw 2 | | |
| 22 | 13.46 14G.4 1L21311570 | -19 .17JW.1010 U192 F .8 .7 N NN N N N N N N N N U #mw 2 | | |
| 23 | 13.46 15G.5 2L22411190 | -18 .34JW.2313 U211 F .2 .2 N NN N N N N N N N N U #mw 2 | | |
| 24 | 13.49 16J.3 1L20110950 | -17 .11JW.08 9 U180 F .3 .2 N NN N N N N N N N N U #mw 2 | | |
| 25 | 13.49 17G.4 1L20210920 | -17 .09JW.07 9 U156 F .6 .4 N NN N N N N N N N N U #mw 2 | | |
| 26 | 13.50 18J.4 1L20210870 | -17 .06JW.0410 U 78 F .3 .3 N NN N N N N N N N N U #mw 2 | | |
| 27 | 13.51 19G.3 1L20010910 | -17 .24JW.1912 U207 F .2 1 N NN N N N N N N N N SPWW+12 | | |
| 28 | F7 CIdC032979VLLAMP Priv | Comm 5/82 S275c I 67 -3 106 M-14mMP UpUmFFw#6FCf | | 1 |
| 29 | 13.55 1J.2.9L2111 9920 | -15 .45JW.2312 U241 F .3 .1 N NN N N N N N N N N U #mw 2 | | |
| 30 | 14.00 2J.3 1L20510030 | -15 .19JW.2712 U263 F .3 .3 N NN N N N N N N N N U #mw 2 | | |
| 31 | 14.01 3G.2.8L20410020 | -15 .42JW.3413 U282 F .2 .2 N NN N N N N N N N N U #mw 2 | | |
| 32 | 14.06 4G.4 1L205 9120 | -12 .13JW.1111 U238 F .5 2 N NN N N N N N N N N U #mw 2 | | |
| 33 | 14.10 5J.8 3L202 8860 | -11 .46JW.3212 U315 F .5 .3 N NN N N N N N N N N U #mw 2 | | |
| 34 | 14.15 6J.4 1L194 8010 | -8 .28JW.2311 U309 F .2 .1 N NN N N N N N N N N U #mw 2 | | |
| 35 | F7 CIdD032979VLLAMP Priv | Comm 5/82 S275c I 77 -8 142 M-21mMP UpUmFFw#6FCf | | 1 |
| 36 | 14.39 1A.4 1L19211570 | -18 .27JW.2313 U219 F .2 1 N NN N N N N N N N N U #mw 2 | | |
| 37 | 14.43 2A.5 2L19913980 | -23 .58JW.5218 U183 F .9 7 N NN N N N N N N N N U #mw 2 | | |
| 38 | F8 CIdA033079SCLAMP Priv | Comm 5/82 S 0 Cu Im47 M-1 M84 M-10 m pUm#kEWpg | | 1 |
| 39 | 11.45 1J.2.65199 8390 | -9 .16JW1.818 U536 F 18 9 N NN N N N N N N N N U #mw 2 | | |
| 40 | 11.48 2D.3.83178 6480 | -6 .17JW.1913 U210 F .2 .2 N NN N N N N N N N N U #mw 2 | | |
| 41 | 11.49 3G.3.89178 6330 | -5 .08JW.10 9 U291 F .1 7 N NN N N N N N N N N U #mw 2 | | |
| 42 | 11.51 4G.3.95191 4800 | -2 .50JW.4415 U296 F 30 14 N NN N N N N N N N N U #mw 2 | | |
| 43 | 11.51 5D.2.65192 4820 | -2 .14JW1.116 U502 F 19 9 N NN N N N N N N N N U #mw 2 | | |
| 44 | 11.52 6E.6 25187 4590 | -2 .56JW.2613 U253 F 10 4 N NN N N N N N N N N U #mw 2 | | |
| 45 | 11.52 7D.5 25188 4210 | -1 .57JW.1511 U226 F .1 .6 N NN N N N N N N N N U #mw 2 | | |
| 46 | F8 CIdB033079SCLAMP Priv | Comm 5/82 S 0 Ba BM47 -1 M82 -9 m pUm#kEWpg | | 1 |
| 47 | 12.08 1E.3 1P220 8010 | -9 .25JW.2013 | | |

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 47

[illegible]

TABLE A-4. THE NEW SUPERCOOLED CLOUD DATA BASE (Continued)
Data File No. 48

-----Card Column No.-----
11111111112222222222333333333344444444445555555555666666666677777777778
1234567890123456789012345678901234567890123456789012345678901234567890

Rec.
No. Card (Record) Contents

| | | | | | |
|----|-----------------------|--------------------------------|------------------------|----------|---|
| 1 | F13SyA040379VLLAMP | Priv Comm 5/82 527 Sc 1m39 | *+4 118M-11 Mm | 0-1FWkCf | 1 |
| 2 | 09:29 1G.2.6P188 5900 | 0 .51JW.7817 U390 F .2 | 0 N N N N N N N N N N | 0 W | 2 |
| 3 | 09:29 2J.6 1P186 6230 | -1 .37JW.5016 U302 F .2 | .1 N N N N N N N N N N | 0 W | 2 |
| 4 | F14SyA040479VLLAMP | Priv Comm 5/82 527 Sc 8m37 | *+3 *98M-10 Mm | 0-1FWk5f | 1 |
| 5 | 09:02 1K.3 1L199 8450 | -7 .41JW.3422 U111 F .4 | 1 N N N N N N N N N N | 0 mmW | 2 |
| 6 | 09:08 2D.8 3L208 9780 | -11 .12JW.1013 U113 F .1 | .1 N N N N N N N N N N | 0 mmW | 2 |
| 7 | 09:10 3A.2.8L200 9740 | -10 .08JW.2824 U 78 F .1 | .1 N N N N N N N N N N | 0 mmW | 2 |
| 8 | 10:41 4A.2.5L149 6930 | -4 .33JW.5010 U252 F .2 | .8 N N N N N N N N N N | U mmW | 2 |
| 9 | F14SyB040479VLLAMP | Priv Comm 5/82 527 As 8121M-15 | 127M-16 Mm | 0-1FWk5f | 1 |
| 10 | 09:16 1G.3 1L21512230 | -16 .17JW.6221 U215 F .2 | .1 N N N N N N N N N N | 0 U | 2 |
| 11 | F14SyC04047990QLAMP | Priv Comm 5/82 5 0 50 U437 | *+3 *98M-10 mP | 0-1FWk5f | 1 |
| 12 | 11:55 1G.3 1L209 4830 | -2 .29JW.6318 U366 F .6 | 3 N N N N N N N N N N | U mmW | 2 |
| 13 | 11:56 2A.2.6L207 4830 | -2 .44JW1.018 U458 F .5 | 2 N N N N N N N N N N | U mmW | 2 |

11111111112222222222333333333344444444445555555555666666666677777777778
1234567890123456789012345678901234567890123456789012345678901234567890

APPENDIX B

HOW MUCH DATA IS ENOUGH? COVERAGE OF CLOUD TYPES, WEATHER CATEGORIES AND GEOGRAPHIC REGIONS

The purpose of the analyses in this Appendix is threefold. One purpose is to decide whether the various, major weather factors are all adequately represented in the data base. The second is to determine which weather factors have produced the extreme values of supercooled LWC and cloud temperatures that have been recorded. The third is to attempt to answer the question "how much data is enough?"

In Table B-1 the NACA and modern data are separately analyzed in terms of synoptic category and airmass. The major synoptic categories are listed and the first column of each data set gives the number of data miles recorded in each category. The second column of figures gives the same information as percentages of the total number of data miles recorded in the data set. It is seen that the largest single portion of the NACA data is from low pressure systems but not in the immediate neighborhood of any fronts. Cold fronts are fairly well represented, as are high pressure regions, but the other categories listed are poorly sampled in the NACA data. The 3rd and 4th columns show that the greatest LWCs in the NACA flights were found in Cu or Cb clouds in both high and low pressure regions and also in connection with cold fronts. The modern data are in general agreement except that they also point out lake effect cumulus and orographic (strong upslope) induced cumulus as additional sources of large LWCs. In both the NACA and modern data, maritime airmasses appear to produce the largest values of supercooled LWC.

In an attempt to answer the question "how much data is enough?" an arbitrary but reasonable and workable quantitative rule was devised. The rule states that a minimum of 100 data miles should first be logged in each of the synoptic weather categories listed in Table B-1. Then the maximum observed value of LWC in each category is used to determine how many additional data miles may be required for that category. The reasoning followed here is that the more severe the possible icing conditions can be, the more the host weather category should be studied. Using supercooled LWC as an indicator of icing severity, we establish the rule that each increment of 0.1 g/m^3 in the maximum observed LWC, W_{max} , requires 50 data miles to be logged in the given weather category. Thus, for $W_{\text{max}} = 0.8 \text{ g/m}^3$, for example, a total of 400 data miles is required to establish that "enough" data have been obtained for that particular weather category. If the original value of W_{max} is exceeded while collecting the required number of data miles, then the new and larger value of W_{max} establishes a new and larger requirement for data miles in that category. Finally, a further assessment of 100 data miles is required, in addition to the requirement derived from W_{max} , for any weather category in which there has been a recent, icing-related, fatal air crash.

The resulting data mileage requirements are listed in the 5th column for each data set in Table B-1. The 6th column gives the percentage to which the goal in each category has been fulfilled by the existing data sets. It is seen that, according to the aforementioned rule, only nonfrontal low pressure systems have been sampled sufficiently by the NACA data. It appears that orographic and low ceiling cases were not sampled at all. In the modern data

set, the categories which appear to be adequately sampled are nonfrontal high pressure systems, clouds 100 nmi or farther from surface cold fronts, upslope flow situations and low ceiling cases. Categories still seriously undersampled by modern data are warm fronts, occluded fronts and lake effect clouds.

As with any simple set of rules for complex situations there are bound to be some deficiencies and shortcomings. One difficulty in this case is that although the modern data seem to adequately cover upslope flow and low ceiling cases, the data available for these cases are mostly from one long flight which satisfied both categories at once. In order to insure that at least several different occurrences in each category are sampled, perhaps the foregoing rule should be amended. For example, perhaps no more than 50 data miles from any one cloud system should contribute to any of the synoptic categories, and each data mile should contribute to only one category.

In general, however, this approach seems to be satisfactory and workable. It also appears to be the first documented attempt to devise a logical and quantitative formula for answering the important but elusive question, "how much data is enough?"

In Table B-2, the extreme and average values of LWC, MVD and outside air temperature (OAT) are analyzed by cloud category and geographic region. The geographic regions are those originally used by NACA (Lewis and Bergrun, 1952) and are used here so that geographical coverage by the NACA and modern data may be compared. It is seen that the two data sets compare well in all aspects except for the maximum MVDs of 45-50 μ m in the NACA data in three of the categories, and the difference in minimum OATs observed for layer clouds in the Pacific Region.

TABLE B-1. DISTRIBUTION OF AVAILABLE DATA AND MAXIMUM LATs OBSERVED IN MAJOR AIRMASS AND WEATHER CATEGORIES FOR SUPERCOOLED CLOUDS AT ALTITUDES UP TO 10,000 FEET AGL OVER THE CONTERMINOUS UNITED STATES.

| Major Weather Categories | NACA COMUS Data | | | | Modern COMUS Data | | | |
|---|--------------------------|------------------|---------------------------|-------------------|--------------------------|------------------|---------------------------|-------------------|
| | Data Miles of Total (mi) | Percent of Total | Max LAT, g/m ³ | Assoc. Cloud Type | Data Miles of Total (mi) | Percent of Total | Max LAT, g/m ³ | Assoc. Cloud Type |
| Nonfrontal, high pressure regions | 301 | 9% | 1.0 | CuCb | 796 | 23% | .4 | St, Sc |
| Nonfrontal, low pressure regions | 1301 | 41% | 1.0 | Cu | 204 | 6% | .7 | Cu |
| Cold front (definite involvement) ^b | 467 | 15% | 1.0 | CbCu | 508 | 15% | 1.4 | Cu/Or |
| Cold front (uncertain involvement) ^c | 507 | 16% | 1.5 | CuCb | 926 | 27% | 1.7 | Or/Cu |
| Warm front (definite involvement) ^b | 95 | 3% | .7 | CdCb | 0 | 0% | - | - |
| Warm front (uncertain involvement) ^c | 29 | 1% | .3 | As | 35 | 1% | .2 | St |
| Occluded fronts | 30 | 1% | .6 | Sc, St | 27 | 1% | .3 | Cu |
| Lake effect clouds | (36) ^e | - | .5 | Sc | 182+(84) ^e | 5% | 1.2 | Cu |
| Upslope flow situations | 37+(27) ^e | 1% | .5 | St, Sc | (317) ^e | - | .3 | St |
| Orographic clouds | 0 | 0% | - | - | (671) ^e | - | 1.7 | Or/Cu |
| Low ceiling (IFR) cases | ? | ? | - | - | (315) ^e | - | .3 | St |
| Undetermined | 436 | 14% | .6 | Sc | 784 | 23% | 1.1 | Cu |
| Totals | 3206 | 100% | - | - | 3460 | 100% | - | - |
| Cases definitely involving fronts | 595 | 19% | - | - | 536 | 15% | - | - |
| Airmass Categories | | | | | | | | |
| Maritime | 759 | 24% | 1.5 | Cu, Cb | 956 | 28% | 1.7 | Or/Cu |
| Modified maritime | 83 | 3% | .9 | Cu | 0 | 0% | - | - |
| Continental | 2364 | 74% | 1.3 | Cu | 2484 | 71% | 1.4 | Cu/Or |
| Modified continental | 0 | 0% | - | - | 20 | 1% | 1.2 | Cu |
| Totals | 3206 | 100% | - | - | 3460 | 100% | - | - |

^aFor each weather category the required number of data miles (M) is determined from the formula $M = b W_{max}^{-3}$ where W_{max} is the maximum LAT observed to date for the weather category in question, and $b=500 \text{ mi/g}^3$.

A minimum of 100mi is required for each category, and another 100mi is required in addition to all other mileage requirements for weather categories associated with a recent, icing-related, fatal air crash.

^bMeasurements were within ±100mi of a cold frontal surface, or within ±200mi of a warm frontal surface.

^cMeasurements were more than 100mi from a cold frontal surface or more than 200mi from a warm frontal surface.

^dThese entries include 100mi added because of a known, recent, icing-related, fatal air crash.

^eValues in parentheses are already included in other categories above.

TABLE B-2. GEOGRAPHICAL DISTRIBUTION ^a OF AVAILABLE DATA OVER THE CONTERMINOUS UNITED STATES.

| Layer Clouds (St, Sc, Ns, As, Ac) | | | | | | |
|-----------------------------------|-----------------------|----------------|-----------------------|----------------|-------------------------|----------------|
| | <u>Pacific Region</u> | | <u>Plateau Region</u> | | <u>"Eastern" Region</u> | |
| | NACA Data | Modern Data | NACA Data | Modern Data | NACA Data | Modern Data |
| Data Miles (nmi) | 346(11%) | 329(10%) | 178(6%) | 245(7%) | 2085(65%) | 1948(56%) |
| Events | 53 | 93 | 24 | 41 | 251 | 427 |
| Max LWC (g/m ³) | 0.7 | 1.1 | 0.7 | 0.3 | 0.9 | 0.6 |
| Avg LWC (g/m ³) | 0.2 | 0.2 | 0.3 | 0.1 | 0.2 | 0.2 |
| Max MVD (μm) | 50 | 32 | 29 | 19 | 50 | 30 |
| Avg MVD (μm) | 23 | 18 | 12 | 13 | 13 | 12 |
| Min MVD (μm) | 8 | 7 | 7 | 6 | 5 | 3 |
| Avg OAT (deg C) | -9 | -4 | -6 | -12 | -6 | -11 |
| Min OAT (deg C) | -14 | -6 | -10 | -15 | -23 | -25 |

| Convective Clouds (Cu, Cb) | | | | | | |
|-----------------------------|-----------------------|----------------|-----------------------|----------------|-------------------------|----------------|
| | <u>Pacific Region</u> | | <u>Plateau Region</u> | | <u>"Eastern" Region</u> | |
| | NACA Data | Modern Data | NACA Data | Modern Data | NACA Data | Modern Data |
| Data Miles (nmi) | 484(15%) | 897(26%) | 9(.3%) | 0(0%) | 104(3%) | 33(1%) |
| Events | 97 | 343 | 3 | - | 21 | 32 |
| Max LWC (g/m ³) | 1.5 | 1.7 | 0.2 | - | 1.3 | 1.2 |
| Avg LWC (g/m ³) | 0.5 | 0.4 | 0.1 | - | 0.6 | 0.5 |
| Max MVD (μm) | 45 | 32 | 11 | - | 26 | 21 |
| Avg MVD (μm) | 20 | 19 | 11 | - | 13 | 15 |
| Min MVD (μm) | 10 | 13 | 11 | - | 5 | 9 |
| Avg OAT (deg C) | -10 | -8 | -8 | - | -9 | -6 |
| Min OAT (deg C) | -17 | -17 | -9 | - | -15 | -9 |

^a Geographical regions are shown in Figure B-1.

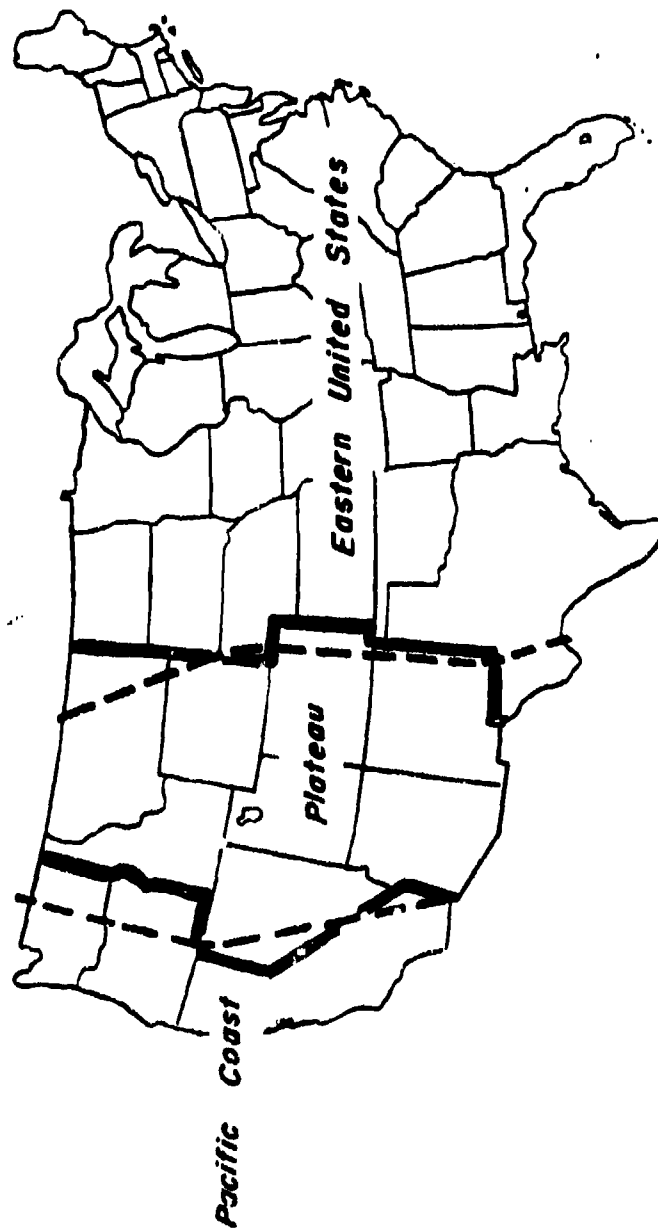


FIGURE B-1. Map of the United States showing approximate boundaries of areas used in the geographical classification of icing data.

--- Boundaries formerly used by NACA.

— Boundaries selected for use in Table B-2.

APPENDIX C

APPLICATION OF THE NEW DATA BASE TO THE ARMY ICING TEST MATRIX

The U.S. Army Aviation Research and Development Command (AVRADCOM) has selected a "matrix" of LWC and OAT combinations to use as test points for qualifying Army aircraft to fly into icing conditions. This matrix is reproduced here in Figure C-1, where the "X" symbols mark the desired combinations of LWC and OAT. At the present time, these test points are used primarily for flight tests behind airborne spray rigs, but they are intended for tests in natural icing conditions as well.

The question that arises at this point is, what is the probability of meeting any given test point in natural icing conditions at altitudes below 10,000 ft AGL, or even below 5000 ft AGL? Such information is needed in order to specify which test points are realistically achievable, or even necessary, in the natural environment.

A second question is, what cloud types, synoptic conditions, geographic locations or air mass types are associated with the difficult-to-find test points?

The new Data Base has been employed in the following ways to answer these questions.

- a) The "X" symbols in the matrix (Figure C-1) are interpreted as representing the centers of "boxes," i.e., small, permissible ranges of LWC and OAT about each "X". Thus for example, any value of LWC within the range of $0.25 \pm .125 \text{ g/m}^3$ combined with any value of OAT within the range $-5 \pm 2.5^\circ\text{C}$ satisfies the test point indicated by the "X" at OAT = -5°C and LWC = 0.25 g/m^3 .
- b) The Data Base is searched by computer for icing events with values of OAT and LWC within each of these boxes for each of the two altitude intervals 0-5000 ft and 0-10,000 ft AGL.
- c) The results are printed out in terms of total number of data miles found to occur in each box. Also printed is the percentage that each of these totals represents compared to the overall number of data miles recorded for all icing events within the altitude interval in question.

These results are shown in Figures C-2 and C-3 for the 0-5000 ft and 0-10,000 ft AGL intervals, respectively.

There are several interesting conclusions to be drawn from these results:

- a) About 33% of the icing events fall outside the limits of the test matrix, mostly on the small LWC side.
- b) Test points in the lower half of the second column and in the entire third and fourth columns of the matrix are nearly impossible to achieve at altitudes below 5000 ft AGL. Even at altitudes up to 10,000 ft AGL test points will rarely be found anywhere in the fourth column and, except for the lower left hand box, the bottom row is practically impossible to achieve.

For the few, hard-to-find cases corresponding to test points in column 4 and row 4 of the matrix, the associated cloud types and weather conditions recorded in the Data Base are summarized in Tables C-1 through C-4.

It is rather obvious that Cu or Cb clouds are required in order to find LWCs represented by column 4. In addition, most of these events were recorded in maritime air masses along the Pacific coast or in ocean-modified, continental air masses offshore along the Atlantic seaboard. Most of the convective cloud events also occurred within 100 to 300 miles behind a cold front. A large percentage of the modern cases were also observed over the windward slopes of the Sierra Nevada mountains in California. These emphasize the fact that windward slopes of mountains, particularly in combination with frontal passages or advection of moist maritime air, are locations where larger than average LWCs can be expected most frequently. However, it is usually necessary to ascend above 5000 ft AGL to find values of LWC that correspond to column 4 of the test matrix.

Concerning the low temperature test points (row 4 of the matrix), it is quite evident from Tables C-2 and C-4 that these events have been recorded so far in stratus or stratocumulus and almost exclusively in the Great Lakes area. Also note that, contrary to the LWC case, altitudes above 5000 ft AGL are not required in order to find clouds at these lowest temperatures, at least in the vicinity of the Great Lakes in January.

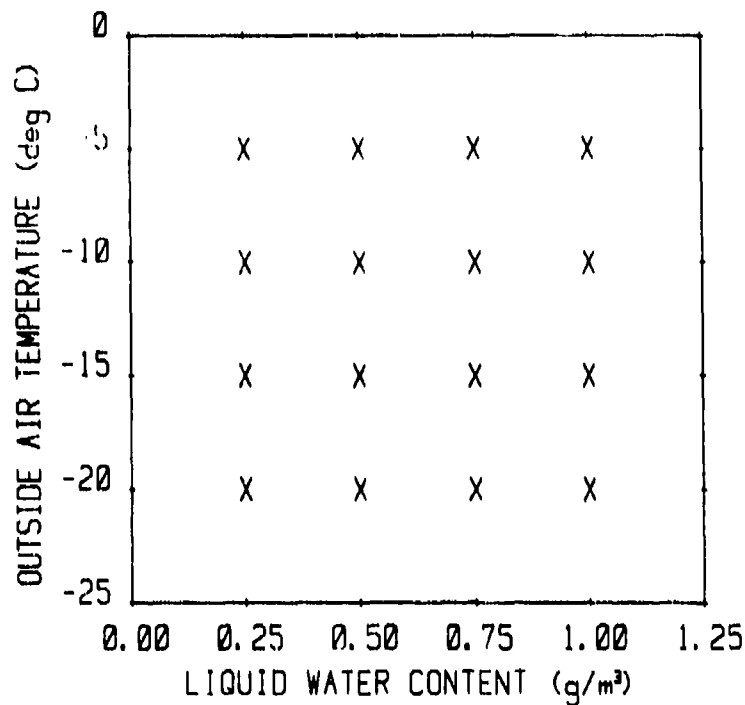


FIGURE C-1. ARMY TEST MATRIX FOR AIRCRAFT ICING TEST FLIGHTS.

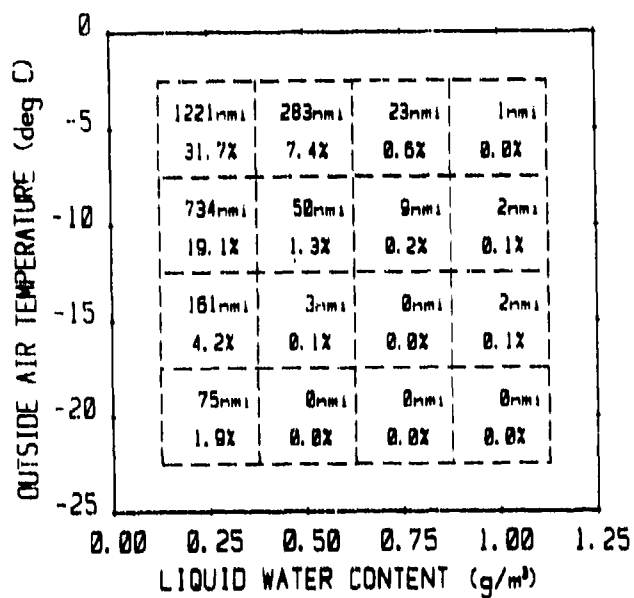


FIGURE C-2. DATA MILES NOTED IN THE NEW DATA BASE FOR INDICATED INTERVALS IN THE VICINITY OF EACH TEST POINT IN THE ARMY ICING MATRIX. Results apply to the altitude range 0-3000 ft AGL. The percentages indicate the fraction of all data miles below 3000 ft AGL that were found in the Data Base for each of the $\pm 2.5^\circ\text{C}$ and $\pm 0.125 \text{ g/m}^3$ intervals centered on the test "points" shown in FIG. C-1. Of 1850 data miles, 2165 (67%) fell somewhere within the 4x4 boxed area. Of the 1265 (33%) data miles which fell outside, 1175 (30.3%) were at lower LWCs, 6 (0.2%) at greater LWCs, 104 (2.7%) at higher temperatures, and 14 (0.4%) were at lower temperatures.

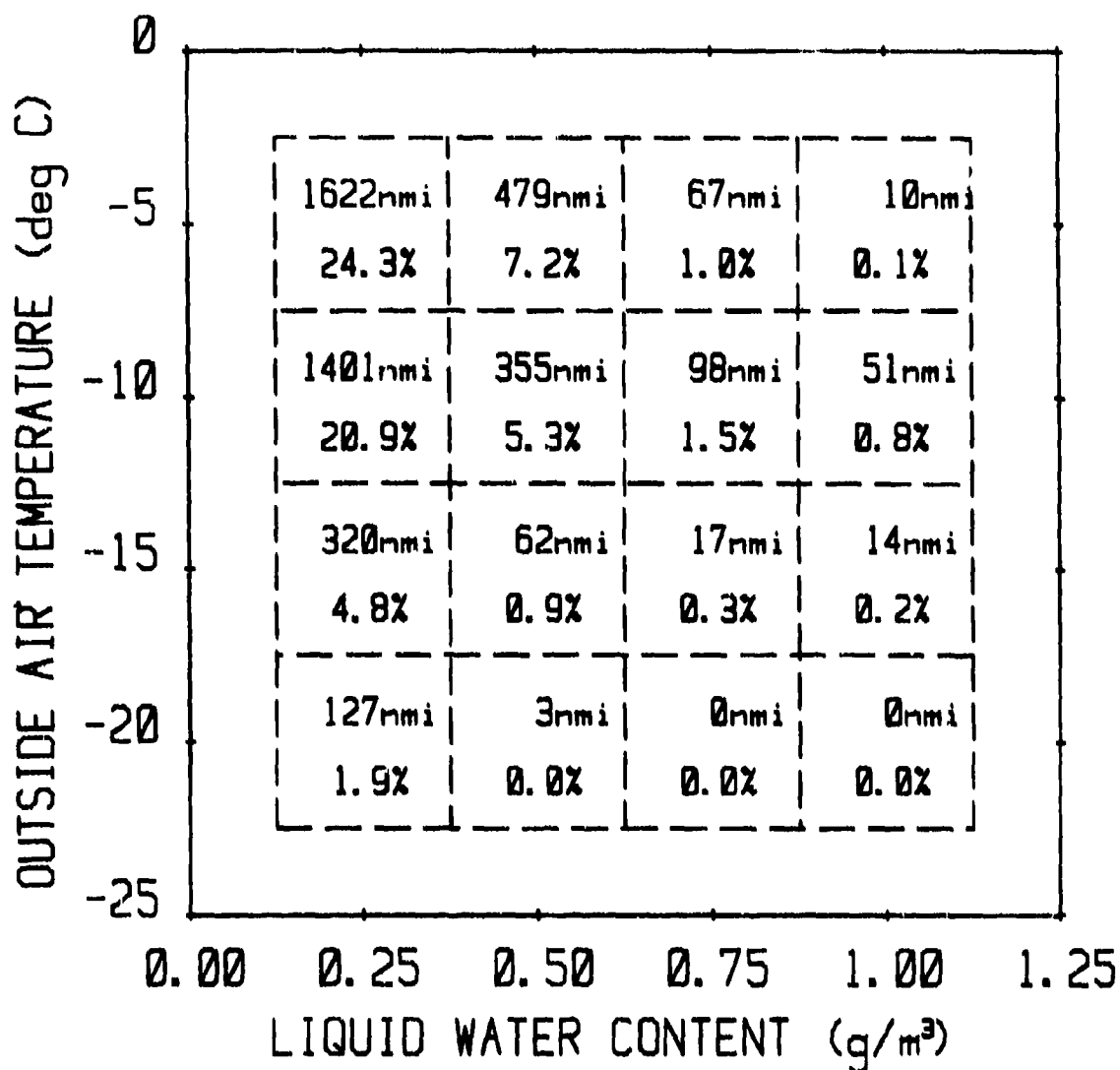


FIGURE C-3. DATA MILES NOTED IN THE NEW DATA BASE FOR INDICATED INTERVALS IN THE VICINITY OF EACH TEST POINT IN THE ARMY ICING MATRIX. Results apply to the altitude range 0-10,000 ft AGL. The percentages indicate the fraction of all data miles below 10,000 ft AGL that were found in the Data Base for each of the $\pm 2.5^\circ\text{C}$ and $\pm 0.125 \text{ gm/m}^3$ intervals centered on the test "points" shown in Fig. C-1. Of 6685 data miles, 4625 (69%) fell somewhere within the 4×4 boxed area. Of the 2060 (31%) data miles which fell outside, 1840 (27.5%) were at lesser LWCs, 50 (0.9%) were at greater LWCs, 185 (2.7%) were at higher temperatures, and 24 (0.4%) were at lower temperatures.

TABLE C-1. NACA Data for LWC > .875 g/m³ (Column 4 of Army Icing Test Matrix)

For the Altitude Interval of 0-5000 Ft AGL

| File/Rec | Cloud Type | Geog Loc. | Air Mass of Yr | Month | OAT degC | LWC g/m ³ | Data Miles | Data Source | Weather Situation |
|----------|------------|-----------|----------------|-------|----------|----------------------|------------|-------------|-------------------|
| 1 /21 | Cu | cOR | MmP | 03 | -11.0 | 0.90 | 2.0 | NACA | 4FSmCf |

For the Altitude Interval of 0-10,000 Ft AGL
(Does not include entries already listed above for 0-5000 Ft)

| File/Rec | Cloud Type | Geog Loc. | Air Mass of Yr | Month | OAT degC | LWC g/m ³ | Data Miles | Data Source | Weather Situation |
|----------|------------|-----------|----------------|-------|----------|----------------------|------------|-------------|-------------------|
| 1 /31 | CuCb | cCA | mP | 03 | -9.0 | 0.90 | 2.0 | NACA | #1-2FSmCf |
| 1 /34 | CuCb | cCA | mP | 03 | -8.0 | 1.00 | 2.0 | NACA | WkHp |
| 2 /30 | CuCb | wOR | mP | 04 | -11.5 | 1.00 | 9.0 | NACA | #2-3FFmCf |
| 2 /31 | CuCb | wOR | mP | 04 | -11.5 | 1.50 | 2.0 | NACA | #2-3FFmCf |
| 2 /33 | CuCb | wOR | mP | 04 | -10.5 | 1.50 | 2.0 | NACA | #2-3FFmCf |
| 4 /15 | Cu | HB | cP | 04 | -13.3 | 0.94 | 2.0 | NACA | Ua, Hp |
| 8 /18 | CbCu | cOR | mP | 03 | -14.4 | 0.95 | 5.0 | NACA | #1FCf |
| 10 /16 | CuCb | SEA | mPk | 05 | -10.6 | 1.40 | 3.0 | NACA | 2FSmCf |
| 11 /30 | CuCb | wPA | cP | 05 | -13.3 | 1.00 | 5.0 | NACA | Ny#5FCf |
| 11 /32 | CuCb | wPA | cP | 05 | -8.3 | 1.00 | 3.0 | NACA | Ny#5FCf |
| 11 /36 | Sc | sLE | c | 11 | -8.3 | 0.88 | 6.0 | NACA | #2-4FCf |
| 13 /27 | Cu | AUD | cP | 04 | -8.3 | 1.30 | 14.0 | NACA | Wy#4FFmCf |

TABLE C-2. NACA Data for OAT < -17.5 degC (Row 4 of Army Icing Test Matrix)

For the Altitude Interval of 0-5000 Ft AGL

| File/Rec | Cloud Type | Geog Loc. | Air Mass of Yr | Month | OAT degC | LWC g/m ³ | Data Miles | Data Source | Weather Situation |
|----------|------------|-----------|----------------|-------|----------|----------------------|------------|-------------|-------------------|
| 4 /20 | Sc | nOH | cP | 12 | -21.7 | 0.09 | 3.0 | NACA | Hp, WkNyCy? |
| 4 /37 | StSc | MKG | c | 01 | -20.0 | 0.16 | 3.0 | NACA | #15&FW? |
| 4 /39 | StSc | EAU | cP | 01 | -22.8 | 0.10 | 9.0 | NACA | FCf |
| 4 /41 | StSc | DLH | c | 01 | -17.5 | 0.13 | 6.0 | NACA | #2-3AWkLf |
| 4 /51 | StSc | LE | cP | 01 | -20.0 | 0.16 | 3.0 | NACA | NyCy&FFmLo |

For the Altitude Interval of 0-10,000 Ft AGL
(Does not include entries already listed above for 0-5000 Ft)

| File/Rec | Cloud Type | Geog Loc. | Air Mass of Yr | Month | OAT degC | LWC g/m ³ | Data Miles | Data Source | Weather Situation |
|----------|------------|-----------|----------------|-------|----------|----------------------|------------|-------------|-------------------|
|----------|------------|-----------|----------------|-------|----------|----------------------|------------|-------------|-------------------|

No additional events beyond those listed for 0-5000 Ft

TABLE C-3. Modern Data for LWC > .875 g/m³ (Column 4 of Army Icing Test Matrix)

For the Altitude Interval of 0-5000 Ft AGL

| File/Rec | Cloud Type | Geog Loc. | Air Mass of Yr | Month | OAT degC | LWC g/m ³ | Data Miles | Data Source | Weather Situation |
|----------|------------|-----------|----------------|-------|----------|----------------------|------------|-------------|-------------------|
| 26 /28 | OrCu | MCC | m | 12 | -3.4 | 1.30 | 3.0 | UWYU | Um1-2FCf |
| 26 /30 | OrCu | MCC | m | 12 | -3.4 | 1.20 | 2.0 | UWYU | Um1-2FCf |
| 26 /31 | OrCu | MCC | m | 12 | -3.4 | 1.30 | 0.8 | UWYU | Um1-2FCf |
| 29 /19 | CuDr | MCC | mp | 02 | -6.2 | 1.05 | 0.9 | UWY | Um2FWkCf |
| 41 /13 | Sa | HQM | mp | 02 | -2.2 | 1.05 | 0.4 | UWSH | 1W&ASf, &2-JE&ACf |
| 42 /23 | CuCb | OLM | mp | 04 | -1.7 | 0.91 | 0.4 | UWSH | Um2-3FFmCf&0f |
| 42 /28 | Cu | HQM | mp | 04 | -0.1 | 0.84 | 2.0 | UWSH | Um2-3FFmCf&0f |

For the Altitude Interval of 0-10,000 Ft AGL
(Does not include entries already listed above for 0-5000 Ft)

| File/Rec | Cloud Type | Geog Loc. | Air Mass of Yr | Month | OAT degC | LWC g/m ³ | Data Miles | Data Source | Weather Situation |
|----------|------------|-----------|----------------|-------|----------|----------------------|------------|-------------|-------------------|
| 17 /36 | Cu | AST | mp | 05 | -4.6 | 0.80 | 1.0 | MRI | EWPGAHo |
| 26 / 8 | CuDr | MCC | mp | 02 | -8.1 | 0.80 | 0.6 | UWY | Um2FCf&WkLo |
| 26 /15 | OrCu | BLU | m | 12 | -6.4 | 1.70 | 2.0 | UWYU | Um1-2FCf, SrCv |
| 26 /47 | OrCu | BLU | m | 12 | -13.2 | 0.89 | 2.0 | UWYU | Um1-2FCf |
| 27 /25 | CuDr | MCC | mp | 02 | -8.0 | 1.05 | 1.0 | UWY | Um2FCf&WkLo |
| 27 /36 | CuDr | MCC | mp | 02 | -8.6 | 0.88 | 0.8 | UWY | Um2FCf&WkLo |
| 27 /39 | CuDr | MCC | mp | 02 | -8.8 | 1.08 | 2.0 | UWY | Um2FCf&WkLo |
| 27 /40 | CuDr | MCC | mp | 02 | -8.6 | 1.30 | 0.6 | UWY | Um2FCf&WkLo |
| 27 /42 | CuDr | MCC | mp | 02 | -8.5 | 0.95 | 1.0 | UWY | Um2FCf&WkLo |
| 27 /45 | CuDr | MCC | mp | 02 | -8.9 | 1.02 | 2.0 | UWY | Um2FCf&WkLo |
| 27 /54 | CuDr | MCC | mp | 02 | -8.3 | 1.09 | 2.0 | UWY | Um2FCf&WkLo |
| 28 / 3 | CuDr | MCC | mp | 02 | -8.5 | 0.97 | 2.0 | UWY | Um2FCf&WkLo |
| 28 / 6 | CuDr | MCC | mp | 02 | -8.7 | 0.96 | 0.9 | UWY | Um2FCf&WkLo |
| 28 /10 | CuDr | MCC | mp | 02 | -8.5 | 0.91 | 0.9 | UWY | Um2FCf&WkLo |
| 28 /22 | CuDr | MCC | mp | 02 | -8.0 | 1.10 | 2.0 | UWY | Um2FCf&WkLo |
| 29 /21 | CuDr | MCC | mp | 02 | -7.9 | 1.25 | 1.0 | UWY | Um2FWkCf |
| 29 /27 | CuDr | MCC | mp | 02 | -7.0 | 1.30 | 2.0 | UWY | Um2FWkCf |
| 29 /33 | CuDr | MCC | mp | 02 | -7.7 | 1.10 | 1.0 | UWY | Um2FWkCf |
| 29 /35 | CuDr | MCC | mp | 02 | -7.3 | 1.05 | 1.0 | UWY | Um2FWkCf |
| 30 /50 | CuDr | MCC | mp | 03 | -10.6 | 1.20 | 4.0 | UWY | M1AFmCf |
| 30 /52 | CuDr | MCC | mp | 03 | -10.5 | 1.10 | 3.0 | UWY | M1AFmCf |
| 30 /54 | CuDr | MCC | mp | 03 | -10.7 | 1.10 | 1.0 | UWY | M1AFmCf |
| 31 / 2 | CuDr | MCC | mp | 03 | -10.0 | 1.30 | 6.0 | UWY | M1AFmCf |
| 31 / 4 | CuDr | MCC | mp | 03 | -10.6 | 1.30 | 2.0 | UWY | M1AFmCf |
| 31 / 8 | CuDr | MCC | mp | 03 | -11.7 | 1.40 | 3.0 | UWY | M1AFmCf |
| 31 /10 | CuDr | BLU | mp | 03 | -11.9 | 1.00 | 1.0 | UWY | M1AFmCf |
| 31 /17 | CuDr | BLU | mp | 03 | -12.4 | 1.10 | 1.0 | UWY | M1AFmCf |
| 35 / 5 | Cu | W72 | Ma | 03 | -5.7 | 1.20 | 0.3 | NRL | LeCvD GulfStream |
| 35 /12 | Cu | W72 | Ma | 03 | -5.4 | 1.10 | 0.5 | NRL | LeCvD GulfStream |
| 35 /23 | Cu | W72 | Ma | 03 | -7.0 | 1.00 | 0.2 | NRL | LeCvD GulfStream |
| 35 /24 | Cu | W72 | Ma | 03 | -7.0 | 0.90 | 0.2 | NRL | LeCvD GulfStream |
| 35 /25 | Cu | W72 | Ma | 03 | -7.0 | 1.00 | 0.4 | NRL | LeCvD GulfStream |
| 35 /26 | Cu | W72 | Ma | 03 | -7.0 | 0.90 | 0.2 | NRL | LeCvD GulfStream |
| 35 /28 | Cu | W72 | Ma | 03 | -7.5 | 1.00 | 1.0 | NRL | LeCvD GulfStream |
| 40 /10 | Cu | SEA | mp | 12 | -3.0 | 1.00 | 0.2 | UWSH | 0-.1ACfSu&F1 |
| 40 /16 | Cb | SEA | mp | 12 | -1.0 | 1.10 | 1.0 | UWSH | 0-.1ACfSu&F1 |
| 40 /30 | Cu | HQM | mp | 01 | -4.3 | 1.10 | 3.0 | UWSH | Ud&CfSu&F1, &3mRb |
| 40 /39 | Sa | 237 | mp | 02 | -4.5 | 0.81 | 1.0 | UWSH | 1W&ASf, &2-JE&ACf |
| 42 /21 | CuCb | OLM | mp | 04 | -8.7 | 0.93 | 1.0 | UWSH | Um2-3FFmCf&0f |
| 42 /22 | CuCb | OLM | mp | 04 | -4.8 | 1.20 | 3.0 | UWSH | Um2-3FFmCf&0f |

TABLE C-4. Modern Data for UAT < -17.5 degC (Row 4 of Army Icing Test Matrix)

For the Altitude Interval of 0-5000 Ft AGL

| File/Rec | Cloud Type | Geog Loc. | Air Mass | Month of Yr | DAT degC | LWC g/m ³ | Data Miles | Data Source | Weather Situation |
|----------|------------|-----------|----------|-------------|----------|----------------------|------------|-------------|-------------------|
| 18 /49 | Sc | MKG | CA | 12 | -17.6 | 0.12 | 1.0 | UWY | Hp#6FFmCf, 156 |
| 21 / 2 | St | cLM | CA | 01 | -19.4 | 0.09 | 3.0 | UWY | U, Wk 155 |
| 21 / 3 | St | cLM | CA | 01 | -19.5 | 0.10 | 5.0 | UWY | U, Wk 155 |
| 21 / 4 | St | cLM | CA | 01 | -19.9 | 0.06 | 3.0 | UWY | U, Wk 155 |
| 21 / 5 | St | cLM | CA | 01 | -20.8 | 0.12 | 1.0 | UWY | U, Wk 155 |
| 21 / 6 | St | cLM | CA | 01 | -22.2 | 0.17 | 1.0 | UWY | U, Wk 155 |
| 21 / 7 | St | cLM | CA | 01 | -23.1 | 0.17 | 1.0 | UWY | U, Wk 155 |
| 21 / 8 | St | cLM | CA | 01 | -23.1 | 0.16 | 4.0 | UWY | U, Wk 155 |
| 21 / 9 | St | cLM | CA | 01 | -21.8 | 0.14 | 17.0 | UWY | U, Wk 155 |
| 21 /10 | St | cLM | CA | 01 | -21.6 | 0.11 | 20.0 | UWY | U, Wk 155 |
| 21 /11 | St | cLM | CA | 01 | -22.1 | 0.10 | 5.0 | UWY | U, Wk 155 |
| 21 /12 | St | cLM | CA | 01 | -22.4 | 0.13 | 6.0 | UWY | U, Wk 155 |
| 21 /13 | St | cLM | CA | 01 | -22.0 | 0.23 | 2.0 | UWY | U, Wk 155 |
| 21 /14 | St | cLM | CA | 01 | -22.4 | 0.13 | 2.0 | UWY | U, Wk 155 |
| 21 /15 | St | cLM | CA | 01 | -22.4 | 0.13 | 18.0 | UWY | U, Wk 155 |
| 21 /17 | Sc | cLM | CA | 01 | -20.3 | 0.07 | 2.0 | UWY | U |
| 21 /20 | St | cLM | CA | 01 | -20.3 | 0.08 | 12.0 | UWY | U, pC10 |
| 21 /21 | St | cLM | CA | 01 | -20.7 | 0.10 | 20.0 | UWY | U, pC10 |
| 21 /23 | Sc | cLM | CA | 01 | -22.5 | 0.12 | 2.0 | UWY | U |
| 21 /24 | Sc | cLM | CA | 01 | -22.2 | 0.08 | 2.0 | UWY | U |
| 21 /25 | Sc | cLM | CA | 01 | -22.1 | 0.17 | 3.0 | UWY | U |
| 21 /26 | Sc | cLM | CA | 01 | -21.7 | 0.09 | 2.0 | UWY | U |
| 21 /27 | Sc | cLM | CA | 01 | -21.4 | 0.08 | 2.0 | UWY | U |
| 21 /28 | Sc | cLM | CA | 01 | -21.3 | 0.10 | 3.0 | UWY | U |
| 21 /29 | Sc | cLM | CA | 01 | -20.1 | 0.08 | 2.0 | UWY | U |
| 21 /34 | Sc | cLM | CA | 01 | -18.1 | 0.06 | 1.0 | UWY | U, 164 |
| 21 /35 | Sc | cLM | CA | 01 | -19.0 | 0.07 | 1.0 | UWY | U, 164 |
| 21 /44 | Sc | cLM | CA | 01 | -18.9 | 0.07 | 6.0 | UWY | U, 164 |
| 21 /45 | Sc | cLM | CA | 01 | -18.5 | 0.12 | 7.0 | UWY | U, 164 |
| 21 /46 | Sc | cLM | CA | 01 | -18.4 | 0.17 | 6.0 | UWY | U, 164 |
| 22 / 3 | Sc | cLM | CA | 01 | -18.5 | 0.23 | 1.0 | UWY | U, pC10 |
| 22 / 6 | St | cLM | CA | 01 | -19.4 | 0.10 | 3.0 | UWY | U, Wk 158, pC10 |
| 22 / 7 | St | cLM | CA | 01 | -19.8 | 0.08 | 4.0 | UWY | U, Wk 158, pC10 |
| 22 / 8 | St | cLM | CA | 01 | -19.9 | 0.10 | 3.0 | UWY | U, Wk 158, pC10 |
| 22 / 9 | St | cLM | CA | 01 | -19.2 | 0.05 | 1.0 | UWY | U, Wk 158, pC10 |
| 22 /10 | St | cLM | CA | 01 | -18.1 | 0.01 | 1.0 | UWY | U, Wk 158, pC10 |
| 22 /12 | St | cLM | CA | 01 | -19.4 | 0.06 | 2.0 | UWY | U, pC10 |
| 22 /13 | St | cLM | CA | 01 | -18.9 | 0.06 | 2.0 | UWY | U, pC10 |
| 22 /14 | St | cLM | CA | 01 | -18.3 | 0.06 | 3.0 | UWY | U, pC10 |
| 22 /15 | St | cLM | CA | 01 | -17.9 | 0.11 | 2.0 | UWY | U, pC10 |
| 22 /16 | St | cLM | CA | 01 | -18.4 | 0.14 | 1.0 | UWY | U, pC10 |
| 22 /18 | St | cLM | CA | 01 | -18.4 | 0.07 | 3.0 | UWY | U |
| 22 /19 | St | cLM | CA | 01 | -19.2 | 0.15 | 1.0 | UWY | U |
| 22 /20 | St | cLM | CA | 01 | -20.2 | 0.09 | 2.0 | UWY | U |
| 22 /21 | St | cLM | CA | 01 | -20.6 | 0.11 | 5.0 | UWY | U |
| 22 /22 | St | cLM | CA | 01 | -19.9 | 0.16 | 2.0 | UWY | U |
| 22 /23 | St | cLM | CA | 01 | -20.0 | 0.11 | 2.0 | UWY | U |
| 22 /24 | St | cLM | CA | 01 | -20.1 | 0.20 | 2.0 | UWY | U |
| 22 /25 | St | cLM | CA | 01 | -20.1 | 0.13 | 1.0 | UWY | U |

TABLE C-4. Modern Data for OAT < -17.5 deg C (Continued)

For the Altitude Interval of 0-10,000 Ft AGL
(Does not include entries already listed above for 0-5000 Ft)

| File/Rec | Cloud Type | Geog Loc. | Air Mass of Yr | Month | Unit degC | LWC g/m ³ | Data Miles | Data Source | Weather Situation |
|----------|------------|-----------|----------------|-------|-----------|----------------------|------------|-------------|-------------------|
| 21 /30 | Sc | cLM | cA | 01 | -25.0 | 0.03 | 5.0 | UWY | U |
| 21 /31 | Sc | cLM | cA | 01 | -24.6 | 0.11 | 5.0 | UWY | U |
| 21 /36 | Sc | cLM | cA | 01 | -20.3 | 0.26 | 1.0 | UWY | U, 164 |
| 21 /37 | Sc | cLM | cA | 01 | -21.3 | 0.38 | 1.0 | UWY | U, 164 |
| 21 /38 | Sc | cLM | cA | 01 | -20.9 | 0.14 | 2.0 | UWY | U, 164 |
| 21 /39 | Sc | cLM | cA | 01 | -21.2 | 0.24 | 3.0 | UWY | U, 164 |
| 21 /40 | Sc | cLM | cA | 01 | -20.9 | 0.32 | 13.0 | UWY | U, 164 |
| 21 /41 | Sc | cLM | cA | 01 | -19.7 | 0.29 | 18.0 | UWY | U, 164 |
| 21 /42 | Sc | cLM | cA | 01 | -19.9 | 0.17 | 7.0 | UWY | U, 164 |
| 21 /43 | Sc | cLM | cA | 01 | -19.7 | 0.06 | 5.0 | UWY | U, 164 |
| 22 / 4 | Sc | cLM | cA | 01 | -19.2 | 0.19 | 4.0 | UWY | U, pC1LD |
| 24 / 2 | St | cLM | cP | 01 | -19.0 | 0.38 | 1.0 | UWY | U, Wk 171 |
| 24 / 3 | St | cLM | cP | 01 | -18.1 | 0.22 | 1.0 | UWY | U, Wk 171 |
| 24 /15 | St | cLM | cP | 01 | -18.5 | 0.07 | 1.0 | UWY | U, nol |
| 24 /16 | St | cLM | cP | 01 | -19.2 | 0.09 | 1.0 | UWY | U, nol |
| 35 /50 | Sc | HGR | cP | 03 | -18.0 | 0.46 | 1.0 | NRL | NyWm7WnFLc |
| 35 /51 | Sc | HGR | cP | 03 | -18.0 | 0.19 | 2.0 | NRL | NyWm7WnFLc |

APPENDIX D

APPLICATION OF THE NEW DATA BASE TO THE USAF/ETAC CLOUD LIQUID WATER MODEL (3DNEPH AND THE SMITH-FEDDES LWC MODEL)

The U.S. Air Force Global Weather Center (USAF/AFGWC) has been using an Automated Cloud Analysis Model operationally since 1970. Known as 3DNEPH (Three Dimensional Nephanalysis), this computer product provides global estimates of cloud amounts in 15 layers of varying thickness from the surface up to 55,000 ft (16 km) with a horizontal grid resolution of 25 nmi. Up to eight analyses are scheduled per day with additional limited area analyses available on request (Fye, 1978).

Subsequently, the USAF Environmental Technical Applications Center (USAF/ETAC) has begun using computerized procedures for determining LWCs and droplet size distributions in the clouds over limited regions using 3DNEPH data as input (Smith, 1974; Feddes, 1974). A recent application of the LWC computations is the compilation of an "Icing Climatology for Northern Europe" based on the probabilities of encountering supercooled LWCs of various magnitudes in the ten 3DNEPH layers up to 14,000 ft. (Jackson, 1980). In any application the accuracy of the LWC computations depends in part on the maximum LWC that the computer code authors consider possible for various cloud types as a function of temperature (Smith, 1974, Table 3, pg. 8; Feddes, 1974, Table 2, pg. 5). The maximum LWC values given in these referenced tables are apparently based primarily on the Russian work by Borovikov et al. (1963). It is not clear whether the stated maxima are instantaneous (extreme) values or are average sustained maxima at an optimum height in the cloud. In any case it is of interest to compare the maximum LWCs used by the "Smith-Feddes" model to those observed in the new Data Base of the present report.

The comparison is given in Table D-1 where the Smith-Feddes maximum LWC for each cloud type and 5°C temperature interval is ranked according to the percentage of the time equal or lesser LWCs are observed in the Data Base for the same cloud type and temperature range. Thus, for example, if a given value of LWC ranks in the 95th percentile of the Data Base sample, then 5% of the data miles recorded for that cloud type and temperature interval were at LWCs greater than the given LWC. Table D-1 shows that, except for Cu and Cb clouds, the Smith-Feddes maxima are generally smaller than the extreme values that have been observed in the Data Base. Most of the Smith-Feddes maxima fall within the 95th to 97th percentile range. However, this range is probably optimum for the purposes of the Smith-Feddes model because it represents more typical maximum values of LWC than do the higher percentiles. The latter represent extreme values which occur very infrequently.

The Smith-Feddes maxima should probably be increased in those cases where they rank only in the 80th or lower percentiles of the new Data Base. Thus, for example, the Smith-Feddes value of 0.15 g/m³ for stratus clouds at -25° to -20°C ranks only in the 70th percentile and should therefore be increased to about the 95th percentile value of 0.20 g/m³. Inspection of Table D-1 shows that only the stratus and stratocumulus cloud types have Smith-Feddes LWC maxima which need to be increased according to this analysis.

The orographic cloud type is included as a separate category in Table D-1 because this type has been studied specifically in the modern research flights. Orographic LWCs listed in the new Data Base represent altitudes up to 12,000 ft AGL and therefore would be suitable for use in the Smith-Feddes model for many mountainous regions. Any clouds uplifted orographically above 12,000 ft ASL (or 10,000 ft AGL) could be assigned to the cumulus category for maximum LWC determination.

The Smith-Feddes maxima for Cu and Cb clouds are much larger than the maximum in the new Data Base because the former apply to altitudes up to 55,000 ft while the new Data Base is limited to the lowest 10,000 ft AGL. This altitude limitation has no significant effect on maximum LWCs for layer clouds.

As a final comment, we suggest that the 3DNEPH and Smith-Feddes LWC model has great potential for improving the nowcasting and forecasting of aircraft icing conditions. Current procedures rely on infrequent and widely spaced upper air soundings analyzed with the aid of some statistical rules of thumb (ref. "Forecasters Guide on Aircraft Icing," 1980; "Aerographer's Mate 1 & C," 1974). The 3DNEPH draws on a much wider and more frequently updated data base (surface observations and weather satellite imagery in addition to the 12-hourly raobs) and provides readily available and greatly expanded information on the horizontal and vertical distribution of cloud amounts and types. In addition, the Smith-Feddes model ties LWC (and drop size) to temperature and position within the 3DNEPH clouds and allows icing conditions to be specified in terms of estimated amounts of supercooled LWC. This overall approach is clearly superior to the current raob techniques where the identification of clouds is difficult and spotty, and icing intensities can only be inferred from the indicated dewpoint depression or degree of stability or instability along the sounding.

TABLE D-1. COMPARISON OF MAXIMUM LUCs FROM CSAF/ETAC (SKITT-FEDDES) CLOUD WATER MODEL WITH MAXIMUM OBSERVED LUCs IN THE NEW DATA BASE

| Temperature in Cloud at Flight Level: | For Stratocumulus (Sc) Clouds | | | | | For Stratocumulus (Sc) Clouds | | | | | For Kimbostratus (Ks) Clouds | | | | |
|--|-------------------------------|-------|-------|-------|-------|-------------------------------|-----|-----|------|-----|------------------------------|-----|-----|-----|--------|
| | -25 | -20 | -15 | -10 | -5 | -25 | -20 | -15 | -10 | -5 | -25 | -20 | -15 | -10 | -5 |
| | to | to | to | to | to | to | to | to | to | to | to | to | to | to | to |
| New COMUS LUC Data Base | | | | | | | | | | | | | | | |
| Maximum LUC observed below 10,000 ft AGL | 30 | 50 | 70 | 60 | 70 | 50 | 50 | 70 | 90 | 110 | — | — | — | — | 20 |
| 99.9 percentile value of LUC | 30 | 59 | 64 | 57 | 68 | 49 | 50 | 64 | 89 | 91 | — | — | — | — | 20 |
| 99 | 27 | 43 | 40 | 46 | 57 | 44 | 46 | 52 | 85 | 59 | — | — | — | — | 19 |
| 95 | — | 20 | 36 | 30 | 47 | 38 | 30 | 39 | 51 | 51 | — | — | — | — | 17 |
| 90 | — | 19 | 32 | 27 | 42 | 36 | 28 | 37 | 41 | 45 | — | — | — | — | 15 |
| No. of Data Miles represented in given temperature interval: | 136 | 73 | 624 | 761 | 375 | 61 | 172 | 590 | 1248 | 842 | 0 | 0 | 0 | 0 | 27 |
| CSAF/ETAC Max. LUC for all Altitudes | 15 | 20 | 25 | 30 | 35 | 30 | 40 | 45 | 50 | 55 | 40 | 45 | 50 | 60 | 60 |
| 2000 ranking in new COMUS Data Base | (702) | (952) | (802) | (932) | (902) | 802 | 902 | 972 | 952 | 972 | — | — | — | — | [>Max] |

| Temperature in Cloud at Flight Level: | For Altostratus (As) Clouds | | | | | For Altostratus (As) Clouds | | | | | For Altostratus (As) Clouds | | | | |
|--|-----------------------------|-----|------|-------|-------|-----------------------------|-----|------|-----|-----|-----------------------------|-----|------|-----|-----|
| | -25 | -20 | -15 | -10 | -5 | -25 | -20 | -15 | -10 | -5 | -25 | -20 | -15 | -10 | -5 |
| | to | to | to | to | to | to | to | to | to | to | to | to | to | to | to |
| New COMUS LUC Data Base | | | | | | | | | | | | | | | |
| Maximum LUC observed below 10,000 ft AGL | — | — | 20 | 50 | 50 | — | — | 30 | 70 | 50 | — | — | 30 | 68 | 50 |
| 99.9 percentile value of LUC | — | — | 20 | 49 | 50 | — | — | 30 | 68 | 50 | — | — | 30 | 68 | 50 |
| 99 | — | — | 18 | 45 | 47 | — | — | 29 | 51 | 49 | — | — | 29 | 51 | 49 |
| 95 | — | — | 16 | 30 | 37 | — | — | 26 | 39 | 44 | — | — | 26 | 39 | 44 |
| 90 | — | — | 09 | 27 | 27 | — | — | 21 | 36 | 39 | — | — | 21 | 36 | 39 |
| No. of Data Miles represented in given temperature interval: | 0 | 0 | 60 | 164 | 53 | 0 | 0 | 195 | 190 | 47 | — | — | 195 | 190 | 47 |
| CSAF/ETAC Max. LUC for all Altitudes | 20 | 25 | 30 | 30 | 35 | 20 | 35 | 40 | 40 | 45 | — | — | 40 | 40 | 45 |
| 2000 ranking in new COMUS Data Base | — | — | >Max | (932) | (932) | — | — | >Max | 932 | 932 | — | — | >Max | 932 | 932 |

Notes: 1. Values in parentheses () for Sc and As may be slightly underestimated because in the new Data Base the actual cloud type was not always distinguishable from similar types, i.e., Sc and As, respectively, which may occasionally contain slightly greater LUCs.

2. Values in brackets [] are uncertain because of an inadequate number of samples in the new Data Base.

| Temperature in Cloud at Flight Level: | For Cumulus (Cu) Clouds | | | | | For Cumulus (Cu) Clouds | | | | | For Orographic (Or) Clouds | | | | |
|--|-------------------------|------|------|------|------|-------------------------|------|------|------|------|----------------------------|-----|-----|-----|-----|
| | -25 | -20 | -15 | -10 | -5 | -25 | -20 | -15 | -10 | -5 | -25 | -20 | -15 | -10 | -5 |
| | to | to | to | to | to | to | to | to | to | to | to | to | to | to | to |
| New COMUS LUC Data Base | | | | | | | | | | | | | | | |
| Maximum LUC observed below 10,000 ft AGL | — | 60 | 150 | 170 | 130 | — | 60 | 150 | 100 | 120 | — | 40 | 140 | 170 | 130 |
| 99.9 percentile value of LUC | — | 60 | 149 | 159 | 129 | — | 60 | 149 | 100 | 120 | — | 40 | 134 | 164 | 130 |
| 99 | — | 59 | 139 | 127 | 123 | — | 60 | 145 | 96 | 119 | — | 40 | 134 | 127 | 128 |
| 95 | — | 57 | 147 | 102 | 100 | — | 59 | 98 | 72 | 116 | — | 38 | 122 | 104 | 112 |
| 90 | — | 54 | 92 | 75 | 71 | — | 57 | 92 | 66 | 113 | — | 37 | 105 | 78 | 68 |
| No. of Data Miles represented in given temperature interval: | 0 | 56 | 483 | 738 | 255 | 0 | 27 | 215 | 222 | 21 | 0 | 26 | 187 | 404 | 84 |
| CSAF/ETAC Max. LUC for all Altitudes | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | — | — | — | — | — |
| 2000 ranking in new COMUS Data Base | — | >Max | >Max | >Max | >Max | — | >Max | >Max | >Max | >Max | — | — | — | — | — |

* In the present context, orographic clouds refer to those formed or assisted by uplifting over the windward slopes of mountains. Lee or wave clouds are classified separately as lenticular clouds.

GLOSSARY

The terminology used in this report has the following definitions or meanings.

Icing encounter - a series of icing events consecutively penetrated until an interruption of more than some selected distance, such as 1, 3, or 10 nautical miles is experienced.

Icing event - a portion of a subfreezing cloud over which portion the cloud properties are approximately constant as defined by the "Rules for Defining Uniform Cloud Intervals" in Table 1.

Liquid Water Content (LWC) - the total mass of water contained in all the liquid cloud droplets within a unit volume of cloud. Units of LWC are usually grams of water per cubic meter of air (g/m^3).

Median Volume Diameter (MVD) - the median of the cloud droplet size distribution computed after weighting each droplet by its volume. The MVD divides the LWC of the droplet population in half according to droplet size.

Mixed Phase Cloud - a subfreezing cloud composed of snow and/or ice particles as well as liquid droplets.

Orographic Cloud - a cloud formed or assisted by uplifting over windward slopes of mountains. Lee or wave clouds are classified separately as lenticular clouds.

Subfreezing Cloud - any cloud or portion thereof in which the temperature is below 0°C .

Supercooled Cloud - a subfreezing cloud in which the droplets are still liquid and no significant amount of snow or ice particles are present.